The Triangulation and Measurement of the Forth Bridge.

BY REGINALD E. MIDDLETON, M. I. C. E.

No. I.

The writer proposes in the following paper to give a description of the setting out of the Forth Bridge, the tools and instruments used, and the amount of accuracy obtained, along with some remarks on the instrumental and personal errors.

General Description of Sites.—It is necessary, in order to be able to understand what follows, that a short description of the site of the bridge be given, which will be further illustrated by the accompanying diagrams, Nos. 1 and 2. Diagram No. 1 is a plan showing the center line of the bridge by a line *A C*, and the system of triangulation in lines *A O*, *C P*, etc. Diagram No. 2 is a section through the center line of the bridge showing the different stations on line *A C*. The total length of the bridge between centers of abutments is 8080.5 feet, and the level at these points is about 110 feet above Ordnance datum, the ground falling very rapidly in each case to a level about 15 feet above Ordnance datum. The distance from the south abutment to high-water mark is about 560 feet, and from the north abutment 1785 feet, the distance which is inaccessible at high-water being approximately 5735 feet, or one mile and one-twelfth nearly. At low water this distance is about 120 yards less. At high water the Island of Inch Garvie, at the center line of the bridge, is covered, but a small brick pier had been built by the contractors for the old Forth Bridge, which is 54.71 feet north of the center line of the northern Inch Garvie piers, which gives an accessible point there at all times of tide. This point, called *B* is 4024 feet from the south shore and 1711 feet from the north shore or thereabouts.

Fig. 1

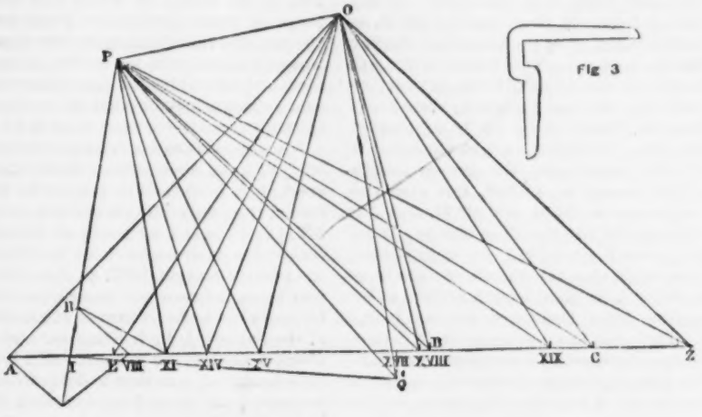


Fig 3

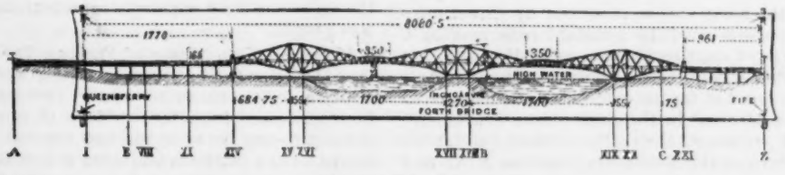


Fig. 2.

Base Line to be Measured.—When the writer went to South Queensferry in the early part of January, 1883, it was desired to make an immediate start with the foundations of the piers on both sides of the Firth, and to this end it was necessary to fix, at the earliest possible moment, the distance of two points, one on the north and one on the south side, and their relative distance from the point *B* on the Island of Inch Garvie. To effect this purpose a base line must be measured of suitable length and a careful triangulation made. The writer therefore ordered the materials for making three standard rods 12 feet long and he inspected the borders of the Firth of Forth on both sides, in order to decide on the direction and approximate length of the base line to be measured and the position of the observatory from which the main triangulation should be made.

Position of Base Line and Observatory.—The writer soon found that there was only one satisfactory course for the base line to take, namely, from a point called *I* in the center line of the bridge, near the face of the south abutments down the center of a siding laid by the North British Railway Company from South Queensferry station to the Forth Bridge works, which is straight for about 2,000 feet, when the line begins to curve to the right; along the platform of South Queensferry station, across the line, up the side of the cutting diagonally, over a bridge over the line, down a short lane, through a fowl pen, and then across a steadily rising open country for about 1500 feet, and finally falling slightly for the last 500 feet; the end of the base line thus laid out being called *P*. The two ends of the base line were, unfortunately, not visible from each other at the ground level, therefore high poles had to be used for sighting; and though every care was taken to place and keep the poles vertical, some slight error may have crept in, and it would have been better to have constructed a timber or masonry stage at *P*, whence the bottom of the pole at *I* could have been seen. The approximate length of the base line was 4,000 feet. The author also decided that, within a few feet, there was only one place suitable for an observatory, namely, near the outer end of a rough stone jetty, run out by the North British Railway Company for about 1300 feet into the Firth to protect the harbor of Port Edgar.

Ordnance Survey.—In the meantime Mr.—now Sir John Fowler—the engineer-in-chief, desiring to have a check on the general measurements across the Firth, arranged with the Ordnance Survey Department that they should send down a qualified man to take up some of the points in the main triangulation, and insert in the measurements three stations in the center line of the bridge, one being on the south side, one being on the north, and one on Inch Garvie Island at *B*. Accordingly a sergeant of Engineers came down, bringing with him a 12 inch transit and a 7 inch Everest's theodolite; he picked up the old stations and inserted the new ones *A* on the south side. *B* on the island, and *C* on the north side, and at the writer's suggestion also included the position marked out for the observatory at *O*. The distances thus measured were given by the Ordnance Department, as being:—*A C*, 7607.37 feet; *A B*, 5401.45 feet; *B C*, 2205.92 feet. The sergeant of Engineers also gave the distance *A I*, as measured with standard chain, as being 846.75 feet and *C D*—*D* being a point near the Fife piers—as 501 feet.

Commencement of Setting out Piers on North Side.—It being desired to commence operations on the north side, the above measurement from *C* to *D* was taken as correct, and the center for the northern Fife piers set out from it; this distance, when measured with standard rods, was found to be 0.79 feet too short, the true dimension being 501.79 feet, and this caused the whole structure to be set out 0.79 feet south of the setting as originally proposed.

Standard Rods.—The rods when delivered had to be corrected to a standard length, but for this purpose no adequate preparation had been made, and the writer was obliged, for want of better appliances, to content himself with a female gauge made of iron tipped with steel, fitted at the time of measurement to two 6 feet boxwood rods, supposed to be standard, and checking the same by means of steel tapes and boxwood scales. The boxwood rods being laid on a bed of a planing machine, the female gauge was made to fit them, and immediately transferred to the rods to be made standard, which were adjusted to it by means of hard wood wedges provided in one end of each rod for this purpose. Each rod was treated in this manner, and the whole were then checked with the steel tapes, and a length set out with 12-inch scales on the machine bed and the whole averaged, the gauge was again adjusted to these rods and put by for future reference. Any error such as would be likely to exist in these standards would not have been of the least importance, as both the foundations and steel work would have been set out from the same standard, if it had not been that the main point of reference were set out from the Ordnance Survey, necessitating that survey being taken as the standard of length for the whole. What the differences were, and how they affected the structure, will appear as the work progresses.

Measurement of Base Line.—The measurement of the base line commenced about February 25th. At first the rods were supported on blocks of wood, each rod being approximately levelled transversely, and then brought to a level longitudinally by means of packings of wood laid under it, the level used being an ordinary mason's level. This arrangement was found to be both tedious and liable to accidents and error, owing to the difficulty in bedding the blocks firmly, and to the inexperience and carelessness of the men assisting, and though frequent bench marks were plumbed down and secured, a good deal of the work had to be done over again. Wooden trestles, with two cross-bars each and of varying lengths, were therefore made and driven into the ground, and the rods rested on them, two trestles to each rod. The line from the

works to South Queensferry Station is straight, but falls with an even gradient of 1 in 70 towards Queensferry, and this gradient, if followed regularly, is just enough to prevent the rods facing. It was therefore necessary to lay a length of three or four rods level, and then make a drop, which, in order to introduce a plumb bob or the square, which was frequently used for bringing the faces of the rods into a vertical plane, and which will be described with the other tools, could not be less than 5 inches. The rate of progress was at the commencement about 24 feet an hour. The highest rate attained was about 86 feet per hour, and the average about half the last amount. At the end of each period of measurement a strong peg was well driven into the ground, and a nail put into the head of it where the measurement ended. The distance from the last peg and nail was taped, and that distance added to former measurements and recorded. The total length of the base line *I. P.*, as measured by the rods, was 4013.2 feet. While the above measurement was being made a staging was in course of erection at *O*, sufficiently large to support an observatory, and a platform two planks wide was laid from the main land along the jetty to the site of the observatory; and when the main base line was completed, the writer proceeded to make a rough measurement from the termination of the former at *P* to the site of the observatory at *O*. This line *P O* was much more difficult than the former, the fall being rapid, and it being necessary to cross the Queensferry branch of the North British Railway on a slight skew, where it is in some 20 feet of cutting; to cross a gulley on a considerable skew; to get down a steep bank, and to cross a quarry hole full of water, and about 120 feet wide. As this measurement was only required as a check, the same amount of accuracy was not attempted as in the main base line, only the portions of ground which were easily measurable with the standard rods being set out with them; the rest of the distance, about 900 feet, was measured with a steel sounding wire.

Measurement with Wire.—In order to use the wire, a distance of 300 feet was accurately measured with the rods on the stage leading to the observatory. The wire was laid on this, a mark having been previously made near one end by means of a piece of copper wire twisted round the steel and soldered on; it was pulled straight and a similar mark was made at the other end. The wire was then transferred to the place to be measured, stretched from the last fixed point, set straight with the theodolite, and held in place by its being lashed to two of the trestles already mentioned as being used to support the rods, these trestles being again lashed to other shorter trestles placed behind them. The accuracy of the starting point was tested by the plumb bob, and corrected by tightening or loosening the lashings of the trestle nearest *P*. The difference of level between the ends and the center was taken with a spirit level, and the distance was marked down, calculated, and booked. The wire was then tested for length on the standard laid down on the stage, and the error, which was a gradually increasing one, and eventually amounted to 9 inches, was also booked.

Error in Line P O.—The results of the whole measurement between *P* and *O*, amounting in distance to about 3,000 feet, could only be looked on as an approximation. It was, however, eventually found to be correct within about 2 inches.

Triangulation.—The next step to be taken was to ascertain the value of the angles to be measured, and for this purpose a 7-inch theodolite, constructed by Messrs. Negretti and Zambra, had been procured, and the writer proceeded to take the several angles at *I*, the commencement of the base line, at *P* its termination, at *O* the observatory and termination of the second base line, at *B* the fixed point on Inch Garvie Island, and at *C* a pole put in by the Ordnance Survey Department in the center line of the bridge, on the north side of the Firth, and so calculate the lengths *I B*, *I C*, from the base line *I P*. In order, however, to compare the measurements so arrived at with those made by the Ordnance Survey Department between *A B*, *A C*, it was necessary to have the distance *A I* accurately measured, and when this was done it was found that *A I* was 846.77 as against 846.75, as given by the chaining of the Ordnance Survey Department. Deducting this length from *A C*, the distance *I C* should have been, in order to agree with the Ordnance Survey, 6760.62. It was, however, found to be by triangulation from base line *I P* 6759.46, or 1.16 shorter. If reduced to the same terms, the proper length of base line would be 4013.89, but also the length *A I* would be 846.91, not 846.77, and *I C* will be 6760.48, and the base line 4013.80. It is, however, proved elsewhere by comparison with 10 feet rods, that the length of this base line was 4013.897, the final length arrived at by triangulation from Ordnance Survey being 4013.693. The error in measurement, or rather the difference between this standard and that arrived at from the Ordnance Survey, in which a possible error of 3 inches is allowed for in 7609 feet, is 0.204 feet or $2\frac{7}{16}$ inches in 4013 feet, or .386 = $4\frac{5}{8}$ inches in 7607 feet, or .086 = $1\frac{1}{16}$ inches in 1700 feet, the 10 feet standard rods being shorter to this extent than Ordnance measurement. It was, as has been before stated, necessary to accept the distance given by the Ordnance Survey as correct, and this triangulation and subsequent measurements proved conclusively that the difference was not appreciably greater than the above, namely, 0.21 feet in 4000 feet.

Setting out Piers on North Side.—The piers on the north side were set out by direct measurements with the standard rods, making *C* the fixed starting point in each direction. At each pier four stones were set in concrete and marked for future reference. Bench marks were also cut in the rock where convenient, and permanent theodolite stations built at the centers of the Fife piers, stations XIX. and XX.

Setting out Piers on South Side.—On the south side a similar course was pursued, starting at *I*; the difficulties, however, were much greater, owing to the rapid slope of the ground, approximately 1 in 2, which made it impossible to measure lengths of 12 feet, and exceedingly difficult to keep the rods steady. The measurement of the first 436 feet was therefore repeated three times, but in the meantime No. 1 pier, station IV., had to be commenced with such information as was then obtained. As none of the measurements *I E* agreed absolutely, a station was fixed at the bottom of the slope by triangulation from a short base line, and the further measurement carried on from this point; this proved the setting of Pier No. 1 to be 2 inches out. At 436.14, according to this measurement, a brick pier was erected to serve as a theodolite station, and a standard bench mark for levels; also at this point, which was close to high-water mark, it was necessary to transfer the survey line from the center line of the bridge to a line parallel to the center line, so that it might pass along the stage erected alongside the piers. A point was therefore squared off and marked down on a stone, and in order to maintain a parallel line, sighting poles were placed in conspicuous positions in this line on the north and south sides, and at the same time poles were fixed accurately in masonry piers 60 feet on either side of the center line of the bridge on both sides of the Forth to maintain the center lines of the caisson piers. All these poles were set out with the standard rods, and wherever poles were placed they were fixed in a substantial manner in stone, brick, or timber piers from 6 feet to 8 feet square, and a railing was run round each, to which the pole was in many cases stayed on top, and on which a canvas screen could be stretched to protect the instrument in stormy weather.

Setting out Piers from E to XIV.—Having now a point in a line parallel to the center line of the bridge at 436.14 feet from *I*, and poles on both sides of the Firth to maintain the parallel line throughout, the measurement was proceeded with up to the center of No. 5 pier, or to 839.14 feet in the measurement, and was subsequently carried on to the center of the south cantilever pier, station XIV.

Wire Measurements between Stations XVIII. and XIX.—A theodolite station having been erected on Inch Garvie Island, in the center line of the two northern caisson piers, station XVIII., at 54 71 feet south of station B, Mr. Baker was desirous to check the distance from the similar station XIX. at the southern Fife pier by an independent measurement, and this he proposed to do by means of a sounding wire of steel about $\frac{1}{10}$ inch diameter and weighing about 9 pounds for a length of 1,800 feet. It thus became the author's duty to make this measurement in conjunction with Mr. P. W. Meik, M. I. C. E., the resident engineer, who represented Sir John Fowler and Mr. Baker at the Forth bridge.

Measuring Wire on North British Railway.—A suitable site for the measurement of the wire was found alongside the railway between the Forth Bridge Works and Dalmeny station. The distance, viz., 1700 feet, was first measured as already described, and was subsequently checked by squaring off at both ends and running the rods along a rail in the line and calculating the error due to gradient, and the difference between the two measurements was $\frac{1}{2}$ inch.

Marks on Wire, Means of Fixing.—The distance between the two posts carrying wooden clips in which the wire was to rest having been measured from face to face of clips, a point half-way between the two stations was marked and a platform laid down 25 feet below the level of the clips, a mark having been made on the wire by means of a copper wire twisted and soldered on, and a further mark being provided 6 inches from the last by means of a brass clip; the point thus marked was brought to the face of the northern clips and fixed there, the wire was paid out and carried through the southern clips, and then tightened until the center was 1 foot above the central platform, thus giving a versed sine of 24 feet. The center and north end were then marked by wire twisted on and soldered, and by a clip 6 inches off, as in the case of the northern end; the wire was then coiled on its drum and was ready for use.

Preparations for Wire Measurements in Situ.—To use the wire similar posts were built into stations XVIII. and XIX., and clips were fixed on them in the positions fixed for the centers of the piers. A theodolite station was fixed in such a position on the island that the axis of the instrument should be 24 feet below the centers of the clips, and on the north side a marked board was fixed at the same level, so that it was only necessary to sight on the board, and the line thus obtained would give the proper deflection for the wire. It is true that there is a slight error for curvature, but it is so small that it may be ignored. On a perfectly calm day arrangements were made for preventing any shipping passing through the northern channel; the wire was fixed in

the clips at station XIX., and was hauled across to the island, where it was brought up to the clips, so that the mark on the wire touched the face of the clips; it was, however, found necessary to draw in the wire 18 inches before the proper deflection of 24 feet was obtained. The span then appeared to be 18 inches too short.

Result of Wire Measurement Unsatisfactory.—This result was eminently unsatisfactory, but before it could be accepted it was necessary to refer the wire to its place on the railway, where, however, it fitted exactly. It was therefore necessary to look for the error elsewhere, and the writer proceeded at once to test the rods on the 300 feet standard laid down on the stage leading to the observatory, when he found that the rods were .173 feet longer in 300 feet than they were when this standard was laid down; .173 feet in 300 feet is .9067 in 1700 feet, or 10⅞ inches, leaving 7⅛ inches still to be accounted for. It may here be stated that the writer can in no way account for the whole of this enormous error in the rods at this particular time, for it was abundantly proved by later measurements that up to that time, with the exception of one measurement between stations XIX. and XX., the maximum divergence from the original setting had not exceeded .024 feet in 300 feet. At the time of the wire measurement, that is, in the end of October, 1843, the rods were checked from the iron gauge, and a small error may be accounted for by difference of temperature; but as the average temperature in February, when the gauge was made, is 42 degrees, and in October 49 degrees, this will only account for an error of about .014 feet in 300 feet, or .078 feet in 1700 feet. The writer can therefore only suppose that the gauge had suffered some injury just at that time. The average error due to temperature would be from 43 degrees to 60 degrees, or 17 degrees, which would give .0335 feet in 300 feet, or .19 feet in 1700 feet; and it will be seen from the records of the rod tests that they do not increase in length with increased temperature to anything like this extent—indeed their tendency is to become shorter during the summer months. Also as the increase in length of the iron gauge due to temperature was known and its effects on the setting out had already been called attention to, this tendency was counteracted, as far as possible, first by keeping the gauge in the most even temperature procurable, and next by allowance in the setting of the rods. Of the 18 inches difference between the wire and the distance set out for a span of 1700 feet between stations XVIII. and XIX., 10⅞ inches has been accounted for, leaving 7⅛ inches unaccounted for.

It has already been shown that to agree with Ordnance measurement, the base line measured as 4012.2 ought to be 4013.80. If this be true, then the rods where the 300 feet base line was set out, were .0523 feet too long in 300 feet, and this will account for .2965 feet in 1700, which, added to .9067 = 1.2032 feet, leaving .2968 feet still to be accounted for; but if the rods were long when the 300-foot standard was set out, the distance C-XIX must also be long to the extent of .0838 feet, also the distance XIX-XX was found to have been set out with the rods as used for the measurement of the wire; therefore this distance was .0896 feet too long, therefore the distance XVIII-XIX was not 1700 feet but 1699.8266 feet, and the error in the wire was not 1.5 feet but 1.3266 feet, or, to reverse the calculation, the corrections on the error of 1.5 feet, are:—.9067 + .2965 + .0838 feet + .0896 feet = 1.3766, leaving error still unaccounted for .1234 = 1 7/16 inches. These are the calculated results. As a fact, the distance XIX-C was proved to be somewhat longer than stated here.

As a further check on this calculation the marks on the poles on the railway were set back 1.3203, and the distance was again measured with the corrected rods and found to be 1700.0078, therefore the set-back should have been 1.3281 as against 1.342 by former calculation, difference .014 or 5/16 inches. In order to verify the results thus obtained, Sir John Fowler determined to procure three rods which should be standard, and when these arrived, a length of 540 feet was measured along a rail on the railway, and marks were cut in the rocks on both side of the line, at each end of the standard, so that a string or wire being stretched from mark to mark, the termini of the standard could be transferred on to the rail at all times, without reference to any movement in the rail itself. A stone bed was also laid down in the cellar of the offices, carefully dressed level, and with brass ends leaded into the stone, the whole being made to fit the 12-foot rods when at their standard length. This was, however, found to be quite useless, owing probably to the stone being in two pieces and laid in a bed of concrete; the concrete expanded, and the stone settled towards the ends. At any rate, whatever the cause, this gauge in a comparatively short space of time was found to be one-sixteenth too long, and from that time forward the rods were always referred to the 540 feet standard. They were not altered in length, except on one or two occasions for special purposes, but a record was kept of the error, and all measurements were corrected to meet the then existing error in the rods. When this standard of 540 feet had been laid down, the 12-foot rods were checked against the 300 feet standard and found to be ¾ inches shorter than that standard in 300 feet. If the base line of 4013.2 feet be corrected to this dimension, it will become 4013.897 feet. As eventually triangulated back from the Ordnance dimensions, it was found to be 4013.693 feet; difference, .204 feet = 2 7/16 inches.

It will be at once concluded from the above remarks that as the rods were too long in the first instance, and therefore station I was set out .16 feet too far north, and station XIX .159 feet too far south, and as on the south side the foundations of the pier had been set up to pier No. 5, station IX, some readjustment was necessary. The error to be corrected was found to be .24 feet between stations IX and XXI—a length of 5349.50 feet. This error was, for the sake of uniformity, divided up between stations XIV and XXI. No actual alteration was required in any pier, but the position of the station was moved to suit the dimensions, which will be found in the tables. At the same time as the 10 feet standard rods were procured by Mr. Fowler, a 12-inch transit theodolite was ordered from Messrs. Cooke & Sons, of York, and this instrument was used in the further triangulation.—*The Engineer.*

THE BOUNDARIES OF NEW YORK AND NEW JERSEY.—Among the measures on the House calendar, and well up on the list for consideration when Congress convenes next month, is that to give consent to an agreement made between commissioners representing New Jersey and commissioners representing New York, respecting the location of the northern boundary line between New Jersey and New York, and the replacing and erection of monuments thereon. The Committee on the Judiciary that examined the measure said that the agreement made by these commissioners was proper and necessary and that Congress should consent thereto. The bill is intended to give effect to the conclusions reached by the commission three years ago, of which Abraham Browning, Prof. George H. Cook and Thomas N. McCarter were the members.

The Statue of Liberty.

As promised several weeks ago, we give herewith an elevation and plan of the Statue of Liberty as erected, and in correction of the original plan as shown in our issue of January 5, 1884. The present plans are reproduced from the drawings of the architect, Mr. Richard M. Hunt, as furnished through the courtesy of Gen. C. P. Stone, the Chief Engineer.

At the risk of repeating matter already published in our issues we briefly sketch the history of this colossal monument. According to a published interview with the sculptor, the idea of erecting this statue was suggested to M. Auguste Bartholdi in 1865; he visited this country soon after the war, studied the situation, selected Bedloe's Island as the most suitable site and in 1874 he started the collection of $250,000 among the people of France to pay for the construction of the statue itself. The right hand and torch were finished in 1875 and exhibited at the Philadelphia Centennial, and afterwards stood for years in Madison Square in this city. The head was finished and placed in the Paris Exhibition of 1878.

The American Committee was organized in 1876 to collect an additional $250,000 for the erection of the pedestal, with the Hon. Wm. M. Evarts as chairman. The gathering of the necessary money was slow and by November, 1884, they had received $161,489.85. Ground was actually broken on Bedloe's Island in April, 1883, the excavation for the foundation was commenced in May and the first concrete foundation laid in October of the same year. The foundation was completed in May, 1884, and the corner-stone of the pedestal laid August 5 of the same year.

In November, 1884, there was a halt due to a lack of funds and work was practically suspended with about fifteen feet in height of the pedestal erected. About this time some controversy arose as to the proportionate height of the pedestal and the statue itself; and partly with a view to economizing in outlay, but really much to its advantage in architectural effect, the pedestal was redesigned and lowered as at present built. The advantages of this new departure were set forth in an illustrated article in our issue of April 18, 1885. At this junction the New York *World*, with laudable business enterprise, set energetically to work to raise the additional $100,000 required to complete the work on the pedestal; and in 147 days this journal announced the collection of $102,006.

The last stone was placed on the pedestal on April 22, 1886. The statue itself was packed and shipped from France on May 21, 1885, and was formally transferred to the American Committee on June 17, 1885, and on July 12, 1886, the last piece of copper in the completed statue was riveted in place. The final dedication ceremonies of October 28, last, are too recent to require note in this connection. The entire cost of the pedestal and statue to this date is put down at about $700,000.

General C. P. Stone was the engineer under whose supervision the pedestal was built and the statue erected; his assistant engineer was first Col. S. H. Lockett, and later, Mr. P. F. Simpson; Mr. Richard M. Hunt designed the pedestal, and Mr. D. H. King, Jr., contractor, had general charge from the laying of the first stone of the pedestal to the driving of the last rivet. The contractors for laying the concrete foundations were Messrs. Drake & McGaw, of New York; the Keystone Bridge Co. manufactured the steel framework which supports the statue.

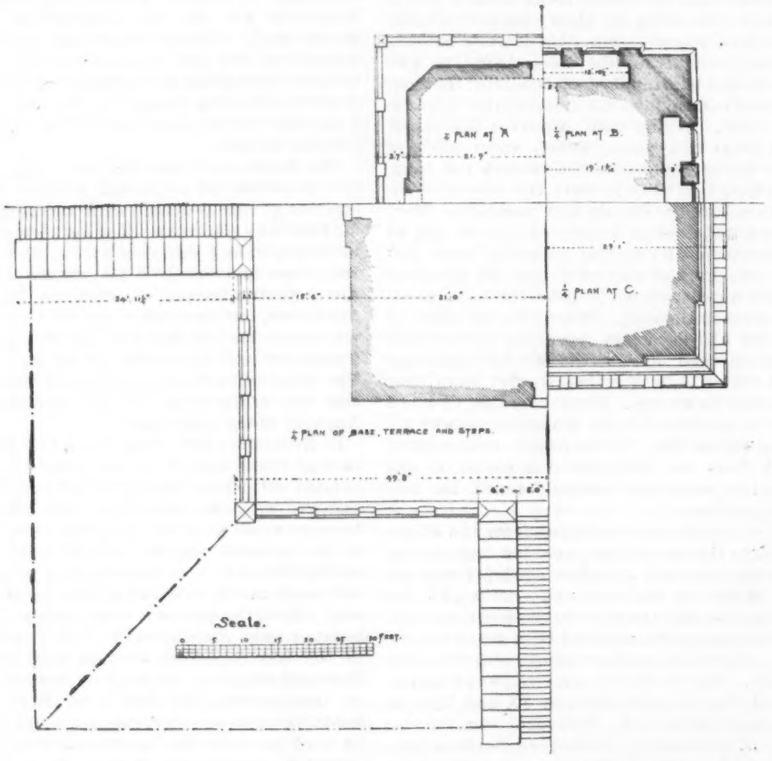
The foundation mass is built of concrete. This foundation is 91 feet square at the base,

65 feet at the top and 52 feet 10 inches high. The first 15 feet 8 inches above the base is formed of a concrete made of two parts Norton Rosendale cement, two of sand and seven of broken trap rock; in the next 12 feet the concrete was mixed with one part Norton Rosendale, one of Portland cement, two of sand and seven of trap-rock; the remaining part was two parts Portland cement, two sand and seven of broken trap-rock. In the centre of this mass is a well-hole 16 feet square, with the same arrangement of concrete arches intended to support the base-mound as shown in our previous illustration.

The general dimensions of the pedestal as given upon the architect's plan may be tabulated as follows:—

Square of pedestal at base	64 feet
Square of pedestal at top	43½ "
Height of pedestal	89 "
Square of central well	27 "
Height from high-water to base of pedestal	60 ft., 10 in.
Height from high-water to top of pedestal	149 ft., 10 in.

In the interior of the figure is a complete system of truss-work about a central framed tower which is 13′ 9″ × 17′ 4″ at the base and 5′ 10″ × 7′ 2″ at the top, up in the head. This tower is divided into eight stories by horizontal and diagonal bracing, and from each bent further bracing extends to and supports the copper-work through the medium of a horizontal ring of angle-iron which is located from 1 to 4 feet from the copper-shell itself; flat and almost vertical bars and angle-irons transmit the weight of the copper to the outer ring and thence to the main framework. The four main tower posts are bolted at their base through broad bed-plates, to two sets of built steel girders whose tops are flush with the top of the pedestal masonry. There are three girders in each set, each girder 4 feet 3 inches deep, and 34 feet long; the web plate is 51 × ⅝ inch with 4 × 5 × ⅝ inch angles. Beneath these girders, and at right-angles to them, are six other girders arranged in sets of three each and of the same dimensions as the first named; the intersections of these cross girders are of course just under the corner-posts of the tower, and the upper and lower sets are connected by saddle plates and three bolts, 5½ inches in diameter, which pass through the corner-post bed-plate at each intersection. Close to the masonry of the well-hole and near the end of each of the double sets of girders are 4½-inch pins securing the tops of eight sets of anchor-bars; each set containing, first, four steel eye-bars, 5′ × 1″ by 25′ 8″ long center to center of pins, and then another set of four similar bars, the two sets connected by a 4½-inch pin. About 52 feet below the first set of girders, and built into the masonry about 7 feet at each end, is another set of girders crossing each other as above. These lower girders have four built channel beams in each set; each beam 41 feet long with web 36 × ⅜-inch and 4 × 5 × ⅝-inch angles at top and bottom. The anchor-bars described above are secured to these lower girders by eye-bolts 3½-inch square with a 4½-inch bolt above and a 4½-inch nut beneath the saddle-plate under the girder.



Statue of Liberty: Plan.

The stone used in the pedestal is Leete Island, (Conn.) granite, partly pointed and partly rock-face as shown; it is laid in Portland cement. This granite face work is backed by concrete made one part Portland cement to four parts of trap-rock screenings.

We have already described how the statue was made, from its first conception as a model 4 feet high in the sculptor's studio to the actual shaping of the copper plates in the shops of M.M. Gaget & Gauthier of Paris, so we will not repeat in this place. We will only say that the copper sheets forming the surface of the figure are two millimetres, or about one-eighth inch thick; the weight of the actual copper used is about 176,000 pounds, and the total weight of the figure is about 460,000 pounds. The copper plates are secured together with ¾ to ⅞ copper rivets with both lap and butt-joints, the lap-joints having one row of rivets and the butt-joints, two rows with an outside cover-plate. All abutting parts of iron and copper are treated with shellac and have a strip of asbestos intervening.

The dimensions of the statue are in accordance with the following general table, gathered from many, and sometimes conflicting, sources:—

	Feet	Inches.
Height from bottom of plinth to top of torch	151	1
Heel to top of head	111	6
Head; chin to crown	17	3
Width of head, ear to ear	10	0
Width of eye	2	6
Length of nose	4	6
Width of mouth	3	0
Length of right arm	42	0
Greatest thickness of arm	12	0
Length of hand	16	5
Index finger	8	0
Size of finger-nail	13 by 10 in.	
Diameter of figure at waist	35	0
Length of tablet	23	7
Width of tablet	13	7
Thickness of tablet	2	0
Total height from low-water to top of torch	305	6

As compared with the other colossi of both ancient and modern times, the Statue of Liberty would rank as follows:—

	Total Height of figure.		figure and pedestal.	
	feet.	inch.	feet.	inch.
Statue of Liberty	151	1	365	6
Colossus of Rhodes	105	0	105	0
Statue of Arminius, (Detmold, 1875)	90	0	183	0
Statue of St. Borromeo, (Italy, 1697)	76	0	114	0
Statue of Bavaria, (Munich, 1880)	51	0	77	0

ACCIDENTS IN MINES.*

VII.

Lime Cartridges.

(*Continued from page* 311.)

Since your Commissioners' first visit to Shipley, the system of coal-getting by lime-cartridges, has been more or less extensively tried in many mining districts in England and Wales and on the Continent, with results which, in the whole, appear decidedly in its favor so far as coal-getting is concerned. This appears to be especially the case in some districts of Derbyshire, Staffordshire, and Yorkshire, where the lime-ca tridge is now continuously and more or less extensively used in several colleries. Its application does not, however, appear to have been attended with uniform success either in very hard or in very soft coal, and seems which are much broken by fissures, cannot be successfully worked with it, as the important auxiliary power, due to the heat developed, is lost by the escape of the steam through fissures crossed by the hole. It is also essential to the success of the the system that the coal to which it is applied should be worked in its entirety (*i. e.*, up to a natural parting), and in faces of at least six yards in width, in order that the practically simultaneous action of several charges may be brought to bear upon the coal. In narrow places the coal must be cut or nicked on one side if any useful work is to be accomplished by the lime-cartridge, and this obviously adds considerably to the labor and cost attending its employment. It is also essential to the efficiency of the lime process that the coal should be properly "holed" or undercut; to attempt its application in the solid face of coal would be as useless as to expect successful results, under the same circumstances, from any kind of mechanical wedge. The nature of the action of the lime cartridge approaches in fact much more

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc." 1864.

THE STATUE OF LIBERTY.—(See page 324.)

nearly to that of the wedge than to that of explosives, and the fulfilment of the conditions essential to the employment of the former appears in most cases indispensable, at any rate, to the attainment of results, with the lime cartridge, which will compare favorably with those furnished by power. No results, of practical importance, appear to have been as yet obtained in attempts to apply the lime cartridge in stone or rock; in work of this nature the disruptive force exerted with comparative suddenness by powder and more violent explosives can only to some extent be competed with by the very laborious operations connected with mechanical wedges. The elaborators of the lime process candidly admit that in such work, connected with collieries, as the ripping of stone in gates and floors, and indeed in all places where, the work being too strong for a single charge of line, the combined effect of several charges cannot be economically adopted, the lime cartridge cannot compete successfully with efficient mechanical wedges, as possible substitutes for explosives.

Some interesting results have, however, quite recently been obtained in the application of the lime cartridge to the dislodgment of solid brickwork, and even of granite blocks bedded in Portland cement.

The question having been raised some time since, whether the heat developed during the action of the lime cartridge, might not suffice to effect this ignition of inflammable substances, such as the paper wrappings of the cartridges, or even the gob into which unslacked cartridges might possibly be thrown, and thus to give rise to the possible ignition of an explosive gas mixture, it was considered important by us to obtain some direct measurements of the maximum temperature developed in a shot-hole during the actual operation of the lime charge. A series of experiments were therefore carried out at the Chemical Department, Woolwich Arsenal, with the assistance of Mr. Sebastian Smith, the results of which have demonstrated conclusively that no danger whatever is to be apprehended in this direction.

It appears to us to have been now satisfactorily established that, for coal getting, the lime process can be to a considerable extent substituted for blasting, in some seams of coal, and we consider that the immunity which its employment secures from certain dangers always more or less attending the application of explosives, should constitute a strong incentive to the managers of collieries to promote its adoption by the men in substitution for powder in mines where freedom from fire-damp and from inflammable dust accumulations may still render the employment of powder admissable, and instead of dynamite, gelatine-dynamite or gun-cotton preparations, where these, in conjunction with water, have to be substituted for powder for coal getting in mines where dangers from fire-damp and coal-dust may be liable to arise.

VIII.

Fire-Damp Indicators.

When fire-damp is encountered in a mine, generally the first sign of its presence is an elongation of the flame in a lamp. This elongation becomes more pronounced as the quantity of gas in the air increases, and gradually a weakly luminous flame of a blue color, due to the combustion of the gas, shows itself, surrounding the enlarged lamp flame. This outer blue flame is generally known as the *cap* upon the lamp flame, but it is sometimes referred to as the *aureole*.

If the gas becomes more abundant, the cap expands, and takes various forms according to the construction of the lamp, until, when the atmosphere becomes inflammable, the entering gas-mixture burns at the inlet of the lamp, and the oil flame is in most cases extinguished.

In the case of an ordinary Davy lamp, the air having access to the flame from all sides, the gauze cylinder becomes filled with the blue flame of the burning gas when it is present in sufficient quantity.

The appearance of the flame in a safety lamp thus furnishes an indication of the presence of fire-damp; hence it has become the practice to test the state of the atmosphere in a mine by carefully observing the flame, and to rely upon the formation of a cap to give evidence that gas is mixed with the air long before an explosive gas-mixture is produced.

In applying this test it is usual to draw down the wick of the safety lamp until the flame is greatly reduced in size and luminosity, so that the pale light of the cap, when it begins to be formed, may be more distinctly visible.

Mr. W. Galloway† seems to have been the first person to observe the size of the cap in gas-mixtures of approximately known composition, and to attempt to infer the percentage of marsh gas present from the height of the cap on a very small flame of a lamp burning vegetable or animal oil. He used in these experiments gas from the blower at Llwynpia Colliery already referred to, which probably contained from 93 to 95 per cent of marsh gas. The gas and air were mixed in carefully measured proportions and passed over the flame in a kind of lantern containing a scale by which the height of the cap could be determined. The circumstances, however, under which the gas-mixture arrived at the flame were different from those which would occur in any safety-lamp, and it is very probable that the height of the cap may be considerably affected by the surroundings of the flame.

More recently Professors Kreischer and Winkler‡ have made similar experiments, in carefully determined mixtures of air and artificially prepared marsh gas, with five different safety-lamps, two burning benzine, two burning rape oil, and one burning a mixture of rape oil and petroleum. From the results obtained it appears that the height of the cap varies considerably, for the same gas-mixture, with the form of the lamp and with the illuminant employed. With the lamp most analagous to the lantern of Mr. Galloway, heights of cap are recorded greatly in excess, in some cases nearly double of those observed by him.

It would appear, therefore, that observations of the height of the cap on a lamp-flame can only lead to a rough estimate of the quantity of marsh gas present in the atmosphere.

The experiments of Messrs. Kreischer and Winkler show that, if the air contains 1 per cent. of gas, the reduced flame exhibits only the faintest traces of a cap when the illuminant is benzine or a mixture of rape oil and petroleum, while with rape oil even these traces disappear. When 2 per cent. of gas is present in the air, the cap may be distinctly seen on the flame of a benzine lamp, almost as distinctly on the flame produced by mixed rape oil and petroleum, but less distinctly on the flame of rape oil. Their experiments also indicate that, for small proportions of gas, the cap is most distinct in lamps to which the air is admitted below the flame, whichever illuminant may be employed.

The lamps used by Professors Kreischer and Winkler were either of the Clanny type, or of the Boty type but with the inlet holes protected by gauze, and they assert that the indications of the presence of gas are less marked with the Davy and Stephenson lamps than with those which they employed. If this be so, the smallest proportion of marsh-gas which can be distinctly detected by the Davy lamp, the lamp generally used in this country for the examination of the air of a mine, is from 2.5 per cent. to 3 per cent.

Mr. A. R. Sawyer, one of Your Majesty's Inspectors of Mines, has made a long series of trials of the Davy, Mueseler, and Marsaut lamps, in gas-mixtures as they actually occur in mines, in order to compare them as means of detecting fire-damp. His conclusion is that the Mueseler is superior to the Marsaut, and very distinctly preferable to the Davy from this point of view.

MM. Mallard and Le Chatelier have also been led by their experiments to rank the Mueseler lamp as superior to the Davy as an indicator of gas. They have attempted to make the former lamp more sensitive by screening the reduced flame by inclined metal plates, one in front of the flame and the other behind it. By this means they state that, when the air contains 0.5 per cent. of fire-damp, a fairly marked cap be distinguished, but one which would not be perceived if very great skill in this kind of observation had not been previously acquired. With 1 per cent. of gas the cap is stated to be distinctly visible, and from 2 to 3 m.m. (0.08 to 0.12 inch) high.

M. Cosset-Dubrulle has made a still further improvement in the Mueseler lamp, when used as a gas detector, by placing against the glass and behind the flame, screened as above, a plate of blackened metal.

The experiments of Mr. Galloway, Sir Frederick Abel and others, have proved that about 2 per cent. of fire-damp in the air of a mine may, when a very inflammable coal-dust is thickly suspended it, produce, under certain circumstances, a violent explosion. It is plain, therefore, that an ordinary safety lamp does not afford the means of ascertaining whether the workings of a mine are sufficiently free from gas to ensure safety.

This circumstance has given increased importance to the instruments which have been devised for the special purpose of indicating the presence of gas, and we have considered it a part of our duty to give careful attention to all suggestions made to us with reference to this class of apparatus. If incandescent electric lamps should eventually replace, to a more or less considerable extent, the ordinary safety-lamp, the miner must be provided with some instrument for detecting the presence of gas. A glow-light, which is the only form of electric light admissible in mine-workings, will of course give no indication of gas, as it is completely excluded from the air, but the existence of sources of danger, independent of the illuminating agent used, will render it as necessary as at present to keep a constant watch over the state of the air in mines.

One of the simplest instruments which has been proposed for this purpose is the spirit lamp of Mr. Pieler, which seems to have attracted considerable attention in Germany. It is a large Davy lamp constructed to burn alcohol with an argand wick; the air supplied to the inner part of the flame is admitted by a tube, protected by superposed discs of gauze, which passes vertically through the vessel containing the alcohol. Around the flame is a short conical chimney, open above and below, and the flame is so regulated that it does not appear above the chimney; its height being, therefore, from 1 to 1.25 inches. In gas this spirit-flame yields a much more conspicuous cap than can be produced by the flame of ordinary vegetable or animal oil. According to Mr. Pieler, 0.25 per cent. of gas is shown by a cap about 1.25 inches high.

†Proceedings of the Royal Society, Vol. 24, 1876.

‡Untersuchungen über Sicherheitslampen, Mauckisch, Freibrg, 1883.

weakly luminous, and with an ill-defined contour; 0.5 per cent. of gas produces a cap, well defined except at its upper end, and at least 2 inches high.

We placed one of these lamps in the box used for testing lamps, already described and a mixture of air and ordinary illuminating gas, adjusted to contain almost exactly 1 per cent. of gas, was passed through the box at a velocity of 200 feet per minute. A very distinct cap of a greyish blue color was seen playing upon and apparently running up the gauze on its lee side. When the lamp was shielded by a glass cylinder, which allowed free access to the gas-mixture, but protected the flame and cap from the mechanical action of the current, the cap became steady along the middle of the gauze and formed a cone fully 6 inches long. Upon cutting off the supply of gas, the air passing as before, the cap at once diminished in length and luminosity, and quickly disappeared altogether.

At our suggestion one of these lamps was tried by Mr. Liveing in the return air of a mine, in which by other methods it was known that about 1 per cent. of gas was present. A distinct cap at once showed itself on the flame extending to a height of 3 inches.

The Pieler lamp is obviously a most sensitive gas detector, but in its present form it is quite inadmissable for use in well ventilated mines for the following reasons: the flame is easily extinguished by a very moderate current, and if the lamp happens to come into an explosive mixture of gas and air, an explosion is almost certain to be caused in a few seconds. The lamp could be rendered less dangerous for general use by enclosing it in a case, and, as far as we have been able to observe, its power of indicating the presence of gas would be but little if at all impaired.

Instruments have been devised for estimating the quantity of fire-damp present in the atmosphere by effecting, with the aid of a heated platinum wire, the combustion of the marsh gas contained in a closed space filled with the air of the mine, and by observing the resultant attraction in the volume of the enclosed gas-mixture. The indicators of Monnier, Coquillion, and Maurice belong to this class.

If the combustion of the marsh gas be complete the resulting products are a n aqueous vapor and carbonic acid. When the temperature and pressure are brought back to what they were before the combination took place nearly the whole of the aqueous vapor is condensed, and in place of two volumes of marsh gas and four volumes of oxygen there remain only two volumes of carbonic acid. The original volume of the mixture of air and fire-damp submitted to this operation is thus reduced by very nearly twice the volume of the marsh gas it contained, when the initial circumstances of the enclosed gas-mixture as to temperature and pressure are restored.

The instrument of Prof. Monnier, to which he gives the name *mètganomètre automatique* though excellent in design, is much too costly and complicated to be employed generally. Moreover, it gives no information as to the state of the atmosphere except at the places, necessarily few in number, at which the combustion instruments are fixed, and even at these places, as the air is tested only at intervals of an hour, very dangerous conditions may fail to be detected in time to prevent accidents.

To be really useful a fire-damp detector must be simple and portable, so that observations may be made readily in any working place or cavity in which gas may accumulate.

A very portable instrument, depending upon the contraction in volume due to the combustion of fire-damp in a closed space, has been constructed by M. Coquillion and he has found that 0.25 per cent. of marsh gas in the closed air is capable of being detected by means of it. M. M. Mallard and Le Chatelier, however, assert in their Report to the French Commission on Fire-damp, that this instrument, in its present form, always indicates per-centages of marsh gas below the true values.

The fire-damp indicator of the same type recently proposed by Mr. A. H. Maurice seems in some respects preferable to Coquillion's. The wetting of the inside of the receiver, which may possibly produce misleading results, is avoided, and the means of measuring the change of pressure are more sensitive and certain, for the india-rubber in the latter instrument introduces possibilities of error. On the other hand it appears highly probable that, with small per centages of marsh gas, the whole would not be consumed in Maurice's instrument in any reasonable time, and per centages below the truth might consequently be recorded. The chance of this error is diminished with Coquillion's very small receiver.

Mr. John Aitken has patented two indicators depending upon the alteration of pressure produced by the combustion of the inflammable constituents of fire-damp contained in a closed space. In one of these the combustion is reduced by a coating of some catalytic substance, such as platinum black, which lines the vessel filled with the atmosphere to be tested, the temperature being either that of the atmosphere or that of boiling water contained in a jacket surrounding the instrument. In the other form a platinum wire heated by electricity is used to bring about the combustion of the gas. These indicators are open to all the objections which can be raised against the instruments of Coquillion and Maurice, and they are inferior to these latter from the point of view of portability and simplicity of manipulation.

The principle on which these instruments is based, is sound, but the method of applying it will need considerable modification before indicators of this class can become generally employed for testing the air of a mine, owing to the time required for completing a test. With the instruments as at present arranged each experiment occupies at least five minutes, probably more nearly ten minutes; it would, therefore, be practically impossible to make the examination of the workings which is necessary before the men are admitted, or to properly comply with the requirement of the Mines Regulation Act as to the examination in the neighborhood of a shot before firing it.

When a heated platinum wire or platinum in a finely divided or porous condition is in contact with a mixture of marsh gas and oxygen or air, the marsh gas is wholly or partially consumed, and the heat generated by the combustion is to a certain extent communicated to the platinum, which consequently attains a higher temperature than it would do if surrounded by air, all other circumstances being the same. Fire-damp indicators depending on this relation between platinum and marsh gas have been brought under our notice by Mr. E. H. T. Liveing, Mr. John Aitken and the late Dr. Angus Smith.

Mr. Liveing utilizes the increased brilliancy of the light given off by a heated platinum wire which is due to the rise of temperature produced as above mentioned. His indicator is constructed as follows:

In a narrow box, about 8 inches long, are fixed two spirals of a fine platinum wire 4 inches apart; these are arranged to have equal electrical resistances, so that when the same electrical current passes through both spirals they are raised to the same temperature. One of these spirals is enclosed in a tube with a glass cover at the end facing the second spiral; this tube is air tight and is filled with pure air. The second spiral is surrounded by a cylinder of wire gauze, also having a glass cover at the end facing the first spiral. Directly between the glass covers is a small wedge-shaped screen placed so that one of the inclined surfaces is illuminated only by light from the first spiral, while the other is exposed only to light proceeding from the second spiral. This screen can be observed through a narrow glass window in the top of the box, and it can be moved until the two inclined faces are seen to be to equally i luminated. The junction lines of the two inclined screens traverses a graduated scale, and its position relative to the spirals can be thus determined.

The box is provided with two tubes, to one of which, if necessary, an india-rubber tube can be fixed with its open end at any place, for instance a hollow in the roof, the atmosphere of which it is desired to test. A sample of this atmosphere is readily drawn into the box by aspirating through the other tube.

In the base of the box is a small magneto-electric machine, and by turning a handle outside the box an electric current can be passed through both the platinum spirals, of sufficient intensity to raise them in air to a moderate red heat.

When the atmosphere is free from marsh gas both spirals glow equally, and the screen must be midway between them, but when this gas is present, even to the extent of one-quarter per cent. of the volume, the brilliancy of the spiral exposed to the vitiated atmosphere becomes greater than that of the spiral in pure air, and in order to restore the equality of the illumination on the two faces of the screen this must be moved nearer to the spiral in pure air. The scale may be so graduated by experiment that the per-centage of marsh gas contained in the air in the box may be at once off,

As the percentage of marsh gas rises, the ratio of the illuminating powers of the two spirals increases very rapidly, as will be seen from the following table, giving the results of observations made by Mr. Liveing, in which the first column represents the percentage of marsh gas present in the air, and the second column the illuminating power of the exposed spiral to that of the spiral in pure air:

0	1
0.25	1.23
0.50	1.52
1	2.24
1.50	3.10
2	4.28
2.50	6.0
3	8.55
3.50	12.7
4	19.3
4.50	31.0
5	51.4

Mr. Liveing has also arrived at the very important conclusion, so far as the utility of the indicator is concerned, that "the rate at which the handle is turned within reasonable limits does not sensibly affect the ratio of brilliancy so long as the exposed wire is heated to tolerable redness." Of course an increase in the velocity of rotation of the handle increases the electric current in the wires, at all events within very wide limits, and consequently increases their absolute temperature and brilliancy. The above-mentioned observation therefore shows that the brilliancy of a wire in a gas-mixture of given composition is proportional to the brilliancy of the same wire in air under the same conditions as to current.

(TO BE CONTINUED.)

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MAGAZINE RENEWALS.

The *Century Magazine* closes its yearly volume with the *October Number*. Renewals are in order for November. The price to ENGINEERING NEWS subscribers and their friends is $3.55; with ENGINEERING NEWS, $8.55. The new *Scribner's Magazine* will be out December 1. Price $2.50 to our subscribers. *Harper's Monthly* is renewable on December 1. Orders ought to be sent in in November to save the publishers trouble.

TABLE OF CONTENTS.

	PAGE
The Triangulation and Measurement of the Forth Bridge (*Illustrated*)	321
The Statue of Liberty (*Illustrated*)	323
Accidents in Mines	324
Editorial Notes	328
The Report of the Executive Board of Rochester, N. Y.	328
Kanawha River Improvement and Lock and Dam No. 6	330
The Philadelphia Electric Pneumatic System	331
Naval Scandals	331
The North of England Board of Conciliation and Arbritration and the Sliding Scale	332
The Panama Canal	332
Russian Petroleum	332
A Comprehensive Business	332
Report of 6th Annual Meeting of the American Water-Works Association	332
Personal	332
American Society of Civil Engineers	333
Engineers' Club of Philadelphia	333
Correspondence	333
Literature	334
Recent Investigations Concerning the Dry-Rot Fungus (Merulius Lachrymans)	335
Water	335
Contracting	335
Market Report	336
Market Summary	336
Building Items	336

THE Chamber of Commerce, of the Port of Rouen, have published a table showing some of the largest vessels that have entered the port during the last six months of 1885. The list contains the names of 191 vessels, steam and sail, drawing from 16 to 20 feet of water, and one drawing 22 feet and 3 inches.

The total movement of the year was 4,150 vessels and 1,457,029 tons. The growing commerce of Rouen will present a strong argument in favor of connecting Paris with the sea by a deep water canal.

THE London *Daily News* has found two statues higher than our "Liberty." They are figures of Buddha, located in Afghanistan on the road between Kabul and Balkh, and have been measured by the Afghan Boundary Commission. The two figures are carved from solid stone, are still erect and are each 173 feet high. They were already in existence in the seventh century A. D., as they were then seen and described by the Chinese pilgrim, Hiouen Thsang.

THE Metropolitan railway project is again to the fore in Paris with the new project of M. Baihaut, Minister of Public Works; this is a circular line starting from the *Place de l'Etoile* and following the boulevards to the *Place de la Bastille* and returning to the starting point by way of the Trocadero; spurs would reach the railway stations and other important points.

This project would cost about $57,000,000, and the guaranteed interest is put down at $2,400,000 per annum. One hundred million passengers at four cents each would meet the guarantee; while in fact over 300 million people are now said to use the omnibuses and tramways of Paris annually.

In the total estimate of cost $30,000,000 is set aside for land damages and $20,000,000 for construction; the remainder would go into the administration and interest for the first two years.

ON the 21st of August the Navy Department issued a circular "To the Steel Manufacturers of the United States of America," asking them to specify, on December 10, 1886, in competition with each other, upon what terms they would prepare to produce and produce steel forgings for guns to the amount of about 1,310 tons for 6, 8, 10, 10½ and 12-inch guns to be delivered in from one to two and one-half years. Also about 4,500 tons of steel armor plates—all to be produced in this country.

On the 6th inst a circular was issued postponing the opening of the bids till March 15, 1887. This looks as if Mr. Dorsey's suggestion that they were proposing to use steel of a higher tensile strength than is thought safe by engineers in bridges, boilers or beams, had been noted and was at least causing discussions if not investigation.

As any intelligent investigation will break up that Department's blind adherence to European precedents, it is to be hoped the investigation will proceed even if we have to wait a few months longer for our guns and armor plates.

THE *Indian Engineer*, of Oct., 2, in commenting upon American vs: English bridge design, admits that American design is economical in material and fulfills very completely the theoretical conditions, but it finds fault with pin-connections.

Our Indian contemporary thinks that the American pin localized the stress in a manner that would insure destruction in case the slightest flaw existed in the material, and that it also causes vibration, and the structure depending upon it lacks the "stability and strength characteristic of English design." In this connection our contemporary sagely remarks that "apart from the discomfort that passengers experience owing to the vibration, it is a sure element of destruction, etc."

This decidedly limber condition of American bridges—from an Indian standpoint—will perhaps be news to the general American public. And we had always supposed that to localize a stress in some one fixed and certain point was very much better than to guess at its vague ramifications about a riveted connection; it is certainly more satisfactory to the calculator and is one of the chief points in securing that "economy in material" which our contemporary commends. The "few extra tons of material" which the English engineer puts in his bridge is just so much metal wasted in the laudable attempt to counter-balance the uncertainty of his calculations; it is a quantity based upon one of the "factors of ignorance" resulting from faulty design. The Forth bridge, to which the *Indian Engineer* points with pride as illustrating the ability of English engineers to satisfy "both theoretical and practical conditions," is one of the very cases in point. Who can tell anything about the division of stress at the bases of the cantilevers, where huge and multiform members intersect and are tied together by plate piled on plate and then riveted through 6 inches of metal?

The Report of the Executive Board of Rochester, N. Y.

The tenth annual report of the Executive Board of the city of Rochester, N. Y., is a model document of its class; and the city is to be congratulated upon the possession of a board which evidently has a lively appreciation of its duties and is earnestly striving to benefit the public by a close and intelligent study of all matters pertaining to municipal improvement. The board is made up at present of Messrs. Geo. W. Aldridge, Byron Holly and Emil Kuichling.

In the form of appendices to the report much information is gathered together that is interesting and valuable to the city engineer. In the first, Mr. Holly treats of street pavements and their repairs; with especial reference to the city of Rochester. This city is considerably removed from the granite formations of New England and the trap rocks of the Hudson, but is in close proximity to the Medina sandstone and to limestone. After assuming that the city may be forced to content itself with these last named materials, Mr. Holly proceeds to discuss the important subject of surface wear and consequent repairs. He found the statistics relating to wear very meagre for American cities, none of them satisfactory, but gives the returns of London and other English cities as furnishing the best data in this direction. We condense this as follows:

In London, with Guernsey granite rolled macadam, (original cost $1.61 to $1.85 per square yard) the average cost of maintenance was about 7 cents per square yard; this cost varied from 3½ to 50 cents, and in some cases as high as $1.00 per square yard for individual cases. The average cost of repairs on London granite block on 36 miles of streets was, up to 1840, for blocks 6 inches wide, 2 cents per square yard per year. During eight years (1848-56) Margate street paved with blocks 3 inches wide cost 7½ cents per square yard per year; and the same street between 1848 64 the average was 9 cents. In 1854 the average cost of repairs on all London granite block pavement was 6 cents per square yard.

In Birmingham, the maximum wear of granite macadam under heavy traffic was a little less than 6 inches in one year (1853); with this one exception the maximum wear was 4 inches and the average wear 2 inches per year. At this rate the cost of maintenance was estimated at 8 cents per square yard per year. Another engineer of the same place puts the average for macadam at 23 cents and for granite block pavement at 2½ cents per square yard per year.

In Derby, Mr. E. B. Ellice-Clark in 1876, from eleven principal streets laid with granite macadam under considerable traffic, put

the annual average cost of maintenance at 22 cents per square yard, and 6 cents for the average of one street laid with granite block pavement.

In Liverpool, Engineer Newland, upon nine streets laid with granite macadam, found for three years (1843-50) that the average cost was about 20½ cents per square yard per year; he found a minimum cost of 7½ and a maximum of 36⅝ cents per square yard.

In Boston, Mass., the average annual cost of maintenance per square yards is reported as $1.00 for macadam roadway, 35 cents for granite blocks, and "$2.00 per square yard for asphalt." In Baltimore granite block pavement cost 36 cents per yard per year. In Rochester, N. Y. with 9,981 square yards of sheet asphalt, 10,923 square yards of wooden block, 261,676 square yards of Medina sandstone block, 18,133 square yards cobble stone, 471,640 square yards of macadam Telford and 282,540 square yards gravel Telford roadways, the statement of repairs stands as follows:

The expenditures for 1885 were $14,400, including repairs to stone cross walks; the average cost of repairs over 1,000 square yards over the whole area was:—

Asphaltum pavement (new)	$ 0.00
Wooden block	64.77
Medina sandstone	4.32
Cobblestone	8.88
Macadam Telford	19 94
Gravel "	8.65

In the above it is to be understood that the repairs made were not such as to maintain even a satisfactory condition of the street surface, but were sufficient to render the streets comparatively safe for public use. The wood pavement is completely worn out and was patched with broken stone and coal tar cement.

In Rochester Medina sandstone block pavement with blocks ranging from 6 to 10 inches long by 8 deep by 2½ to 4 inches thick, costs about $2.25 per square yard including excavation and sand. The Telford macadam costs $0.94 per square yard, including excavation with 10 inches of Telford foundation, and 10 inches of broken stone. The life of the Medina sandstone is put at from twenty-five to thirty years before entire rebuilding will be required, supposing the wear to be one-seventh inch per year. The average sized Medina block lays forty-eight to the yard, and costs in the stone yard about $1.28 per yard of sur- Mr. Holly finds out that at this price the Medina block pavement should be laid at a total cost of $1.91 per square yard, and the cost of maintenance about 7 cents per yard per year. With limestone macadam costing $0.50 per square yard laid, and the lifetime of this surface put at three years (2 inches wear per year), the cost of repairs would amount to 16⅔ cents per yard per year.

Mr. Kuichling, in another appendix, devotes a number of pages to the cleaning and maintenance of streets. He first refers to the removal of ashes and rubbish, and attempts to impress upon householders the importance of acting in concert with the city authorities in this line, and to separate the slops or organic matter from the inorganic waste. He suggests that all combustible matter be destroyed in the kitchen range, instead of being allowed to accumulate about the premises; with such a course generally adopted the result would be a riddance of what otherwise soon becomes offensive, and the removal of a vast quantity of material that finds its way now into the sewers, gives forth noxious exhalations, and must be ultimately removed at great cost.

In speaking of the dust, mud and dirt that so rapidly accumulates on paved and improved streets he ascribes its presence, First.—To the finely divided earthy and organic matter transported by the winds from distant points. Second.—To the wear in the street surface itself, which, according to a large collection of statistics is found to range as follows:—

On granite pavement	0.05 to 0.22 inch per year.
On wood pavement	0.14 to 0.33 "
On granite macadam	1.00 to 6.00 "

As thus shown the inferior classes of pavement create the greatest amount of mud. Third—The earth, soil or sand which works up through the interstices of the pavement as a result of settlement from defective foundation. In gravel and macadam roadways this last is one of the principal causes of mud and ultimate destruction, and can only be remedied by careful underdrainage, which practically means re-construction. With the modern system of water-tight sewers this thorough underdrainage is especially necessary for the maintenance of any permanent roadway. Fourth—Earth, dust and organic matter is unavoidably deposited directly upon the paved street from passing vehicles or animals; and large quantities are washed by rain from unimproved into improved roadways.

The character and composition of mud accumulating upon paved streets varies greatly with the class of pavement. Dr. Letheby and others have analysed samples from London stone-paved streets, and found a complete mixture of water, comminuted stone, earthy matter, horse manure, iron from horse-shoes and wheel tires, and fragments of leather, wood, cloth, paper, etc., in almost endless variety. Organic matter is present in greatest quantity in dry weather and least in wet weather, thus indicating that in the latter case the abrasion of stone and iron is greatest. The average proportions of the principal ingredients of the mud are found as follows:—

	Average.	In dry weather.	In wet weather.
Per cent. abraded stone or minerals	50	41.8	79.5
Per cent. abraded iron	13	41.8	79.5
Per cent. organic matter and manure	57	58.2	20.5
Totals	100	100	100

Dr. Letheby also found the amount of organic matter contained in dried street mud from different London pavements was on the average:—

From stone pavement	22.8 per cent. of the bulk.
From wood pavement	60.0 " "
From macadam pavement	4.0 " "

From this statement it is seen that wood pavement yields the greatest volume of organic matter and macadam the least; but the detritus from the latter is vastly greater per unit of area and it makes up in quantity what it lacks in proportion.

From reports and statistics, principally foreign, the quantities of mud to be dealt with appear as follows:—For convenience these statistics were all reduced to an average roadway one mile long, 37½ feet wide, containing 22,000 square yards. The number of loads, of 1½ cubic yards, collected weekly per mile of roadway containing 22,000 square yards was as follows:—

Manchester, England, macadam, average	15	to 17	loads
Manchester, England, macadam, dry weather		27	"
Manchester, England, macadam, wet weather		81	"
London (Bridge) granite block, dry		101	"
Liverpool, England, granite, asphalt joints	15	to 27.3	"
Liverpool, England, granite, common joints	27.4	to 37.9	"
Liverpool, England, macadam, paved gutters	26.8	to 57.7	"

Asphalt and wooden block develope of themselves small amounts of mud and dust, and this is also true of stone-block with cement, pitch or asphalt joints. In Birmingham, the city engineer reports the largest amounts of mud collected daily per 1,000 square yards of pavement as follows:—

From wood pavement in one day about	0.33 loads.
" common granite " " "	2.00 "
" macadam " " "	12.00 "

The following is given from various authorities as the average quantity of street dirt which experience has proved will form during only a few days upon properly kept roadways in large English towns:—

	1	2	3
	Sq. yds. of road.		
On macadam one load of dirt per	344	250	250
" granite block " " "	500	1000	1500
" wood block " " "	1666	3000	3000
" asphalt " " "	4000		

The figures in columns 1 and 2 are attributed to E. B. Ellice-Clark, formerly City Engineer of Derby; column 3 is taken from a report of the Paddington (London) vestry for 1878.

In summing up upon the foregoing it is seen that the quantity of mud accumulating upon a paved roadway during a given period is very variable. One set of authorities claims that the better the maintenance of a roadway and the oftener it is swept, the less will be the mud accumulation and cost of repairs. As Mr. Kuichling says, this proposition will hardly hold good for stone or wooden block pavement, but appears to be true for macadam. In the latter the smoother the surface is kept the obvious less wear by the wheels of heavy wagons and the less pulverized stone resulting from such abrasion. Thorough cleaning, too, brings to light defects which would otherwise be overlooked. The bulk of evidence from many localities points to the fact that a coating of mud and dirt is generally detrimental to a pavement, notwithstanding the fact that a very few authorities look upon this mud as a protection from wear and injury. Macadamized roads should be cleaned frequently, rather than once or twice per year, but they should be scraped only when the dirt is soft and plastic. The liquid mud is best removed by careful sweeping with soft bass brooms. The experience of Manchester, Birmingham, and other English cities shows that with a proper application of water and sweeping machines a saving of nearly one-third of the material required for the repair of macadam roads can be effected.

Mr. Kuichling reduces the preceding statements to cubic yards of dirt per mile per year, assuming that the streets are cleaned about forty times per year and that 1½ cubic yards of dirt, at each cleaning, are taken from every 340 square yards of macadam, 1,000 yards of granite block, 3,000 yards of wood block and 4,000 yards of asphalt pavement. The result is as follows:—

From macadam	3,880 cu. yds. per mile per year.
" granite block	1,320 " " " " "
" wood block	440 " " " " "
" asphalt	330 " " " " "

The same author next takes up the question of street sweeping. He says that the prices of sweepers range from $300 to $600 and when in good order should be capable of cleaning from 3,000 to 6,000 square yards of surface per hour, according as the sweeper is drawn by one or two horses and as the pavement is in good or bad condition. In a competitive trial in Paris it was found that in one hour an able-bodied laborer with a good broom and a machine operated with a single horse and driver, sweeping a breadth of 5 feet at one passage, would clean the following areas of pavement:—

	One laborer per hour.	One machine per hour.
Macadam roadway, dust, lightly watered, square yards	720	5,000
Macadam roadway, liquid mud, square yards	480	4,800
Macadam roadway, thick mud, square yards	360	Imperfect
Paved roadway, medium order, square yards	600	5,000
Paved roadway, best order, square yards	820	6,000

These figures are evidently maximum figures, as the regular performance of man and machine for ten hours is much less.

Mr. L. W. Rundlett, City Engineer of St. Paul, Minn., has made recent (1885) and care-

ful comparisons of the relative cost of hand and machine sweeping. He found that the maximum cost of hand-sweeping per mile was $30, gradually falling to $18.50 as the men become better trained and organized; this last Mr. Rundlett thinks is the lowest average cost to be obtained with manual labor at $1.50 for ten hours work. A two-horse sweeping machine costing $300 was introduced in 1885, and this machine swept an average of 85,000 square yards of pavement every 24 hours. The actual cost of the work, including removal of sweepings, ranged from $10.35 to $8.48 per mile, with an average of $9.18 per mile as deduced from a total of 39.25 miles. These figures do not include the cost of any ash or rubbish removal, and the paved streets of St. Paul are reported in excellent condition, many being quite new.

Mr. Kuichling enters quite fully into the organization of the work of street sweeping, and from official descriptions of the process adopted in Boston, Mass., and Brussels, Belgium, he deduces the following cost of sweeping up and removing the dust each time from a mile of paved roadway in good condition, the widths given are measured between curbs.

For 66 feet wide,	area	32 720	sq.	yds.	$18.93	per	mile.
" 37½ "	"	22,000	"	"	10.74	"	"
" 36 "	"	22 120	"	"	10.32	"	"
" 33 "	"	19,360	"	"	9.47	"	"
" 30	"	17,600	"	"	8.61	"	"

From these descriptions the cost per square yard for each sweeping would become for Boston, 0.0489 cents, and for Brussels, 0.0455 cents. The following were contract prices per square yard paid in 1885 in the cities named:

Omaha, Neb., on asphalt streets only	0.0170	cents
Washington, D. C., on paved streets only	0.7295	"
" " " on paved alleys only	0.0150	"
St. Louis, Mo., on asphalt street only	0.0125	"
" " " on paved streets only	0.0630	"

A fair average per square yard of the above is about 0.0413 cents; and on a street 37½ feet wide swept 40 times a year the cost of cleaning would be $352.43 per mile per year; or with 30 feet wide, $290.75. The following table gives the *mean* from a long list of reports, etc., of the cost of cleaning various classes of pavements:

	Per sq. yd. per year.
Asphalt	4.633 cents.
Granite block, asphalt joints	4.800 "
" " sand joints	4.090 "
Wood block	5.400 "
Macadam	12.683 "

In connection with the cost of street cleaning per mile per year, Mr. Kuichling has presented this cost in tabular form for a large number of cities, both foreign and American. This table, as might be imagined, shows a wide diversity of cost, ranging from $3,376 per mile for New York (including ashes and garbage) to $1,845 for Vienna, $1,258 for London, $1,290 for Liverpool, and $1,590 for Paris, to sums as low as $195 for Cleveland, O. As the author remarks, it is very difficult to institute a fair comparison of the cost of this work, owing to the imperfect data furnished as to the length of streets actually cleaned, state of pavement, frequency of cleaning, etc. Mr. Kuichling points out the universal benefit to be derived from a more careful statement in municipal reports of the actual work done in this line.

Street sprinkling and snow removal both receive attention in this excellent report, but both refer especially to the city of Rochester. The report of J. Nelson Tubbs, the Chief Engineer of the water-works is also to be commended for its thoroughness.

AT Helena, Mont, a $500,000 water-works system is to be put in at once. This is mainly due to the efforts of Mr J. S. Dickerson. Atlanta, Ga., is discussing the question of accepting the offer of the Newark Filtering Co. to put in a plant to purify the water supply for $54,875; it is probable that the offer will be accepted.

Kanawha River Improvement and Lock and Dam No. 6.

The lock and dam, No. 6, on the Kanawha river slack-water improvement, being completed, we are indebted to Mr. A. M. Scott, Resident Engineer, under Col. Wm. P. Craighill, U. S. Engineers, for the history of this improvement. The machinery of this movable dam on the Chanoine system is exactly similar in detail to that illustrated in our article of May 15th last, describing the Davis Island Dam, so we will not repeat the cuts; the only practical difference is in the substitution, in part at least, of stone masonry for concrete in the foundations and the scale of the works.

To commence at the beginning, previous to 1820, no organized attempt had been made to improve the navigation of the Kanawha river; at this time, the James & Kanawha River Co. was directed by act of the Virginia Legislature to secure not less than 3 feet of water for navigation all the year round from its mouth to the falls, a distance of about 90 miles. This task was a more extensive one than originally anticipated, and nothing was done in the way of work until 1825, when a system of wing-dams and sluices was commenced. In 1855-6 the transportation of coal from this region assumed some importance, and the above named company undertook to provide better facilities for navigation than then existed. A new survey was then made by Engineer Byers, and the reservoir plan was proposed and advocated by the late eminent engineer, Charles Ellett. This plan contemplated the creation of large, lake-like reservoirs near the heads of streams, from which the water was to be let out as required. But the conservative board rejected this "untried experiment," and went on with the enlargement and improvement of the sluice and wing-dam system, and about 1858-9 put this work under contract with Messrs. Barton & Robinson, whose work was finally suspended by the late war.

In 1863, West Virginia, as a separate State, took charge of the Kanawha river and created a Kanawha River Board to improve navigation, collect tolls, etc. About 1871-2 a commission was appointed by the States bordering on the Ohio river and tributaries to gather facts and statistics in regard to the trade, capacity and wants of these rivers, and in their final report and recommendations the Kanawha was included. Congress finally appointed a Senatorial Committee, made up of Senators Windom, Conkling, Bayard, Beck, and Henry G. Davis, accompanied by Gen. Q. A. Gillmore, Col. Godfrey Weitzell, and Col. W. E. Merrill, U. S. Engineers; these gentlemen examined the ground and made a careful and voluminous report. The government then decided to at least improve the Kanawha river, which was needed as a local work and could be used as a part of a long contemplated connection between the Ohio and James rivers, if such should ever be deemed advisable.

In 1872-3, the government commenced with annual appropriations of $25,000, and in June, 1873, work was actually commenced on this river under the charge of Col. W. E. Merrill, U. S. Engineers. This work was at first confined to dredging out the sluices and building wing-dams to meet immediate wants; but it was conceded that nothing short of a slack-water navigation secured by locks and dams would afford a safe, reliable and permanent improvement.

In August 1874, this work was placed under the charge of Col. Wm. P. Craighill, U. S. Engs., and in the March following Congress appropriated $300,000 with which to commence permanent works. Very soon after, a Board of Engineers, made up of Gen. H. G. Wright, Col. Wm. P. Craighill, and Gen. O. M. Poe, recommended the adoption of the lock and dam slack-water improvement, with the use of movable dams below Paint creek and permanent dams above. This recommendation was approved and late in 1875, Locks Nos. 4 and 5 were put under contract.

Twelve locks and dams were at first located between the Falls and the mouth of the river, the three upper ones to be permanent and the nine lower ones to be movable or adjustable. This plan has been since somewhat modified, one movable dam being thrown out and the lift divided between the other eight. The original estimate of cost was $4,071,216.

Commencing above, the dams come in the following order:—No. 1 was to have been located at or near the mouth of Loup creek. This has not been built. No. 2 is just below Cannelton and Coal Valley, is now under construction, and is expected to be completed next season. This is a permanent dam, has a lift of 12 feet, and pools the water to Loup creek, about six miles. No. 3, just below the mouth of Paint creek, was completed in 1882. This is also a permanent dam, has a lift of 12 feet and pools the water to No. 2, about five and one half miles. No. 4, below the mouth of Cabin creek, was completed in 1880. This is a movable dam, with a lift of 7 feet, and pools the water to No. 3, about five and one-half miles. No. 5, near Brownstown, was completed in 1880, is a movable dam, with a lift of 7 feet, and pools the water to No. 4, about six miles. No. 6, near the mouths of Tyler and Davis creeks, about four and one-half miles below Charleston, is just completed, is a movable dam, has a lift of 11 feet at present, which will be reduced to 8½ when Lock and Dam No. 7 is constructed, and pools the water to No. 5, about fourteen miles. No. 7 will be located about one and one-fourth miles below the mouth of Coal river, will be a movable dam with 8½ feet lift, and pool the water to No. 6, about ten miles. This lock and dam will be commenced next spring, if the usual appropriation is made, and be completed about the fall of 1890.

The remaining dams of the series are all to be movable, their exact locations are not yet fixed; but, approximately, they will be as follows:—No. 8, about two miles below Raymond City, with a lift of 8½ feet, and pool of seven miles. No. 9, near Alexander's Landing, with a lift of 6½ feet, and pool of nine and one-fourth miles. No. 10, near Debby's Ripple, with a lift of 7½ feet, and pool of eight miles. No. 11 and the last, at the foot of Three-Mile bar, with a lift of 9½ feet and pool of 16½ miles.

The adjustable dams are the invention of M. Chanoine and have been long used in France; the details are described in the article previously referred to in ENGINEERING NEWS of May 15th. The dams on the Kanawha are the first of this system introduced in America and both Col. Craighill and his assistant, Mr. Scott, first personally and carefully inspected the French dams of this type. The lock and dam No. 6, just completed, is believed to be more nearly perfect than any of its predecessors.

Lock No. 6 is 410 feet 6 inches in extreme length, 342 feet long between quoins and 55 feet wide in the chamber at the top of miter-sill. It is built throughout of first-class masonry, laid in cement, faced with cut and pointed stone; it is founded on the solid rock from 11 to 22 feet below low water mark. The top of the coping is 21 feet 9 inches above miter-sills. The foundations extend from 5½ to 16½ feet below the sills, making the walls from above 27 to 38 feet in height from rock.

The walls are from 15 to 19 feet thick at

bottom, and from 5 to 17 feet thick at top. The lock-gates are of white oak, strongly bolted and ironed. The filling and emptying valves are in the gates, five valves in each leaf. Each gate leaf weighs about thirty-eight tons. They rest and turn on steel pivots and are suspended at the top by iron, steel and bronze fastenings, attached to heavy wrought-iron anchors built in the masonry. The upper fastenings are all below level of coping and are covered with movable cast-iron plates.

The lock chamber has *a clear working space* of 312 feet in length by 55 in width, sufficient to admit one of the largest tow-boats with three of the largest sized coal barges, at once.

The lift of the lock *in extreme low water*, before No. 7 is built, will be 11 feet. After No. 7 is built, the maximum lift will be 8 feet 3 inches.

Dam No. 6 is 568½ feet long between the outer face of the lock wall and abutment, embracing the navigation pass, central pier and weir. The foundations are of masonry and concrete on the solid rock, the average depth from rock to low-water mark being 12 feet.

The sill of the navigable pass is 2 feet 7 inches below low-water. There will be 12½ feet of water on the pass sill when the dam is up and the pool full. The foundations of the pass are 50 feet long up and down stream.

The pass is closed by 62 Chanoine wickets. The wickets are 3 feet 8 inches wide, or 4 feet between centers, (there beiug a 4-inch space between each), and 13 feet 5½ inches long. The pass bridge is composed of 50 wrought iron trestles. The trestles are nearly 12 feet wide on the bottom, 4 feet 1 inch on top and 16 feet 8 inches high. They are connected, when standing, by 4 inch "I" beams, which form the track for the manœuvering winch, and light wrought iron aprons, which make the floor to walk on.

The pass is separated from the weir by the central pier. This is of cut stone masonry 34½ feet long and 10 feet wide. It is built on bed rock, and is about 26 feet high, the top of it being level with the top of the service bridge. The bridge, when lowered, falls towards the pier, and there is a deep recess in the pier in which the nearest trestle lies when the dam is down.

The weir is 310 feet 6 inches long. It is closed with 69 Chanoine wickets each 7 feet 8 inches high and 4 feet 3 inches wide.

Tne weir bridge is like that for the pass, in construction, but the trestles are not as high. It is connected, when standing, with rails and aprons like the pass, and with those of the latter forms a continuous track for the traveling winch, and a foot walk the whole length of the dam, from the abutment to lock.

The foundations of the weir are built entirely of masonry, concrete and iron. A peculiar feature of this weir is the cast iron sills. The wooden sills, etc., at dams 4 and 5, of this improvement, were found to decay rapidly, and iron was accordingly used at No. 6.

The iron sills, trestles, and wicket boxes, etc., are bolted to the cut stone coping, making the upper surface of this part of the dam practically indestructible.

As before mentioned, the foundations of this dam, throughout, are of masonry or concrete. In dams 4 and 5 (both finished in 1880) a great deal of oak timber was used in the foundations of both navigation pass and weir. This timber was framed and bolted together and filled in with concrete. It was found generally more expensive than masonry and was abandoned, as far as possible, in the construction of No. 7. The stone work was found not only better and cheaper than timber, but could be placed faster and saved valuable time in construction.

The foundations of the dam were constructed within coffer dams built in sections across the river, from which the water was kept exhausted by large steam pumps.

The pool formed by Dam No. 6 is nearly fourteen miles long; and with a little dredging at several points, 6½ feet of water will be secured everywhere at extreme low stages of the river.

This lock and dam was built almost entirely by contract with Harris & Black, of Pennsylvania, who commenced operations in the spring of 1881, and finished their part in November 1883. The adjustable dam itself was not commenced until late in 1884 owing to lack of appropriations. The contractors for the foundations and masonry were Messrs. Harrold & McDonald, of Pittsburg, who were engaged in this work from September 1884, to October 1886. The total cost of lock and dam No. 6, including grounds, buildings and complete outfit, will be slightly less than $337,000.

The manœuvering of these Chanoine dams has been previously described, so we will only add that four men can entirely raise one of the Kanawha dams in about nine hours; and lower the dam in four hours, though this last manœuver has been frequently executed, at dams 4 and 5, inside of three hours. The expense of operating dams 3, 4 and 5 in year ending June 30, 1886, including repairs and all attending expenses was as follows:

Lock-and Dam No. 3 (Permanent dam)	$2,575.63
" " " No. 4 (Moveable dam)	2,182.58
" " " No. 5 " "	2,245.11

The engineering force employed on the work from its commencement to the present date was as follows:

Col. Wm. E. Merrill, of the U. S. Corps of Engineers, was in charge of the work from the commencement, in 1873 to August 1874. Col. Wm. P. Craighill has been in charge from August 1874, to date, a period of over twelve years.

Mr. A. M. Scott, C. E., was the local or resident engineer from the commencement of the work by the Government, in 1873, to August 1876, when Capt. Thomas Turtle was appointed, and remained in local charge till the fall of 1880.

Under Capt. Turtle the following engineers were employed: Mr. A. M. Scott, principal assistant, mainly on construction of locks and dams 4 and 5; Mr. C. K. McDermott, Mr. John S. Hogue, Mr. N. A. Baillie and Mr. Chas. Humphreys.

Capt. E. H. Ruffner was the resident engineer during 1881-82, with about the same assistants and organization. Lieut. Wm. H. Black, of the corps of engineers, was on the work from April 1880, until May 1881. Civil engineer Wm. R. Hutton was also employed on the work, in a prominent capacity, in 1875 and 1876.

Mr. Scott has been the resident engineer since January 1883, assisted mainly by Thomas E. Jeffries, engaged particularly on lock and dam No. 6, and by Mr. T. Schoonmaker at lock and dam No. 2. The office has also, at times, had the benefit of the services of Mr. A. M. Campbell and Mr. H. V. Estill, civil engineers, of Charleston, W. Va.

M. E. H. Kirlin and Mr. John H. Minnick have been the principal inspectors on the work from the beginning.

As a result of this improvement of the Kanawha river to date; instead of the few hundred thousand bushels of coal shipped from the Kanawha valley previous to the commencement of this work, 31,815,358 bushels were sent below Kanawha Falls last year, and did the navigation permit the mines to operate on full time 60 million bushels could have been mined.

The Philadelphia Electric Pneumatic System.

The Electric Pneumatic Company of Philadelphia, authorized by Councils last July, is reported to be now in a position to at once commence the construction of its pipe system. The work which this company proposes to do is remarkable even in this very progressive age.

The inventor is Henry Clay, of Philadelphia. The plan includes a combination of electric and pneumatic appliances for the transmision of letters and packages. Instead of a single tube extending from a central station to some final destination, as in the usual form of pneumatic transmission, there is to be a main tube with any desired number of lateral branches. At each branch will be an ingenious switch, controlled by electricity from the central office, by which the main tube will be blocked and the carrier diverted into the lateral way; and in this lateral other switches will shunt the message directly in to the house of the receiving party.

The system consists of two tubes, one a vacuum, the other a pressure tube, and each carrying messages in opposite directions. But as no details are yet made public the exact manner of conducting this traffic can not yet be fully described. It is said that the company propose to establish "stations" at distances of about 2,000 feet, or one-half mile, apart; and from these main-line stations to establish a household service entirely distinct from the main line. The method of operating is described as follows:—From any house or office a directed "carrier" is dropped into the tube leading to the nearest district office, the operator there opens the cone, looks at the address, touches an electric button which closes all the switches except the one leading to a certain store or office, and in an instant sends the message to its address. An arrangement is perfected whereby carriers on the main-line from various districts will not conflict in their flight towards their destination. The estimated speed of transmission is one mile in thirty seconds; the "messenger" tubes will have a diameter of 2½ inches; while the "package" tubes, of course in a distinct service, will be from 18 to 24 inches in diameter. In the latter service, the packages will be distributed from the district offices by messenger boys.

Among the uses to which it is proposed to put this system is the calling of police or firemen by a whistle produced by a carrier dropped into a patrol-box,—a red carrier announces fire in a certain house, a blue one indicates that a policeman is wanted. An arrangement of post-office tubes can also be made, whereby the simple touching of a button will cause the various letter boxes to dump their contents into carriers, and in an instant convey them to the general or district post-office. This latter system can also be connected by branches with private offices.

The President of the Philadelphia company is John C. Scott, and the main office will be at 422 Library street. The system, as announced, will cover the city from the Delaware to the Schuylkill rivers, and from Carpenter to Fairmount avenues in width.

Naval Scandals.

When Congressman Boutelle, on July 24th. last, in his place in the House of Representatives, asserted "I am informed that two or three officers of the United States Government in the city of Washington to-day, are representatives of an English manufactory of armor," he made a charge that should have induced all self respecting men implicated, to demand an investigation. The charge not-

withstanding its gravity, was not novel, for the New York *Tribune* on the 15th of last April said: "One of the line officers of the Navy, a lieutenant, who was one of the members of the Gun Foundry Board, that recently returned from Europe and made its report, brought with him the credentials as United States representative of William Armstrong & Co. Another officer, a lieutenant commander, who has been abroad on a years leave of absence, returned recently as the United States representative of Le Cruesot Works."

But whether the charge was made in April or July, no officer of our Navy has publicly denounced the shameless arrangement, or denied the truth of the charge, and these implicated officers who have been taken from obscure positions as boys, to be educated, fed and clothed by the people of the United States with the understanding that they should as gentlemen, give their services to her honor and defense, stand on or near the Advisory Boards of the Navy, with the low arts of the underling tradesman, trying to postpone the day in which we can be self reliant in the matter of munitions of war, for the sake of the very dirty commissions they hope to draw from Armstrong and Schneider.

The acceptance of commissions is so repugnant to the teachings and traditions of engineers that there has been a general feeling that the charges, both against the Lieutenant and Lieutenant Commander, were based on insufficient information, but the *Army and Navy Journal* publishes a copy of a hektograph letter enclosing quotations from Messrs. Schneider & Co., of Le Cruesot, "which you may find useful in making up your data for bidding for the construction of the new cruisers and gunboats mentioned in the advertisement of the Navy Department;" this is signed F. M. Barber, and it is further asserted that this F. M. Barber is a Lieutenant Commander in the United States Navy, was a member of the Advisory Board which determined the character of our new cruisers, and that Schneider & Co. have had access to information refused to American bidders.

In times past we took just pride in our Navy, as we had the best men, officers and ships with the heaviest and most effective guns in the world, and all of them thoroughly American. Now the naval authorities take care that we have the lightest guns afloat, and we buy rejected plans that prove as impracticable as those of the projected "Baltimore." But we do not believe that the Lieutenant and Lieutenant Commander under discussion are fair samples of our naval officers.

The North of England Board of Conciliation and Arbitration and the Sliding Scale.

Among the efforts to accommodate the ratio with the profits of manufacturers and the wages of laborers, none seem more easily adjustible or more satisfactory than making the wages depend on the price of the article produced and sold, the difficulties being in determining the "basis" and establishing a minimum price for the scale to protect the men and a maximum for the manufacturers.

The North of England Finished Iron Trade have governed the wages paid for puddling by a sliding scale for sixteen or more years; it commenced on the basis of one shilling for each pound sterling the finished iron sold for and further concessions have been made to the men till the pay is now "1s. 6*d*. above shillings per pound selling price," and the men now want 2s. above shillings per pound, with a minimum of 7 shillings per ton. The employers demurred to this, saying that iron making was a very flat and unprofitable trade, employing a small number of men compared with what it did formerly, and further that they had in effect actually been paying what was equal to 2s. above shillings per pound, for the last two years.

Since January, 1885, the wages have been 7*s*. 6*d*., 7*s*. 3*d*., 7*s*. 6*s*. 8*s*. all higher than required by the scale and on September 1st though the men were entitled to but 6s. 3d. the wages still stay at 6s. 8d. At and about Pittsburg the wages are $5 to $5.50 per ton and it is not strange that over 160,000 emigrants left the United Kingdom, two thirds of whom came to this country.

The Panama Canal.

The *Bulletin du Canal Interoceanique*, of November 1st, gives the total cube extracted on the canal works in September, as 989,000 cubic metres. The principal points of work, as far as volume is concerned, were Colon, 126,000, Gatun, 244,000, and La Boca, 117,000 cubic metres. The complete re-organization of the Culebra workings was almost finished; but only 13,000 cubic metres are recorded as the output for that point in September. This return of total work done is 88,000 cubic metres in excess of the August record. and 120,000 over that of July. The total amount excavated in the first nine months of 1886 is 9,236,822 cubic metres, an average of 1,026,313 per month.

Russian Petroleum.

Mr. Percy Tarbutt, in a paper on Liquid Fuel lately read before the Society of Engineers in England, says that the petroleum industry in the Caspian region has developed from 5,400 tons in 1863 to 950,000 tons in 1882, and is now only restricted by the lack of transport. It is reported that it now costs $5.00 per ton to transport the petroleum across the strip of land lying between Baku and Batoum.

Mr. Charles Marvin, an excellent authority, says in his late pamphlet "The Coming Deluge of Russian Petroleum," that there is one Russian oil well that yields daily more than all the oil-wells of the world put together the 25,000 American wells included. He tells us that this well from a 10 inch orifice spouts forth 11,000 tons of petroleum in 24 hours. This is the Tagieff well lately referred to in this journal. Two years were occupied in drilling this well, and on Sept. 27, 1886, the drill struck the oil deposit at a depth of 714 feet from the surface; the jet was 224 feet high and is described as resembling a colossal pillar of smoke, from the crest of which clouds of sand and spray detached themselves and covered the whole region around with dust and petroleum. Nearly 10,000,000 of gallons were lost in this way, by forming a lake and then running into the sea, before storage accommodations could be provided or the jet controlled. Mr. Marvin says that 462 feet is the average depth of a Baku well, and eight gallons of oil can be bought for one cent; millions of gallons are said to be running into the Caspian Sea for want of a buyer.

At present the oil is transported by rail in tanks from Baku to Batoum, or by steamer up the Caspian to the Volga; last year 214½ million gallons were shipped by the Caspian route and 45½ millions by Baku and Batoum. Over one hundred "tank steamers" are occupied in the Caspian trade, and in their construction Russia has spent over $5,000,000 since 1878. The proposed pipe-line scheme is intended to get it to the Black Sea where it can be shipped to any port in the world. This enterprise will consume 600 miles of pipe, the necessary pumps, boilers, etc., and Mr. Marvin's pamphlet is intended to awaken Englishmen to the importance of competing "with the Germans" in the project

A Comprehensive Business.

Messrs. Robert Stephenson & Co. have gone the way of all successful English firms *i. e.* "limited."

The new company have registered as Robert Stephenson & Co.(Limited.)

"To carry on in any part of the world all or any of the following businesses, viz:—Engineers, contractors, shipbuilders, ship repairers, shipowners, ship equippers, riggers, carriers, ironmasters, colliery proprietors, mineowners, miners, and smelters, manufacturers of iron, steel, gas, coke, cement, bricks, tiles, ropes, masts, and spars, founders of metals of all kinds, salt mill proprietors, builders, farmers, merchants, manufacturers, and trades for all purposes and all or any branches of the before-mentioned businesses, or any of them."

Report of Sixth Annual Meeting of the American Water-Works Association.

The printed report of the proceedings of the Sixth Annual Meeting of the American Water-Works Association, at Denver, Col., June 23rd, 24th and 25th, has made its appearance. Members or others desiring extra copies can obtain them by sending thirty cents to the Secretary and Treasurer, Mr. J. H. Decker, Hannibal, Mo.

In addition to a very full report of the proceedings and discussions at this interesting meeting, the report contains the following papers in full:—"Self Closing Work," by B. F. Jones, Kansas City, Mo.; "Water Meters," by L. A. Taylor, Worcester, Mass.; "Discipline in the Pumping Station," by Chas. B. Brush, Hoboken, N. J.; "Lead, etc., as a Poison in Water," by Dr. W. H. Watkins, of New Orleans; "Analysis of Mississippi Water," by Prof. R. N. Girling, New Orleans; "Notes on the Use of Lead Pipe," by Prof. Girling; "Fungus, or Mossy Growth in Clear Water," by E. H. Keating, Halifax, N. S.; "Pumping Engines," by John W. Hill, Cincinnati; "Steam Boilers and their Setting," by Charles A. Hague; "The Relation of Private Water Companies to Municipal Authorities, as they do Exist," by J. G. Briggs; "Cast-Iron Pipe," by G. W. Pearsons, Kansas City, and "Report of the Committee on Coal Tests."

PERSONAL

THOMAS FRANKLIN, civil engineer, employed as a special assistant in the Croton Aqueduct Department, died in New York, November. 15, at the age of 54 years.

FIRST LIEUT. JOHN MILLIS, U. S. ENG., is ordered to report for temporary duty as engineer of the third light-house district, to relieve Brig. Gen. James C. Duane, Chief of Engineers.

JOHN DOUGHERTY, of Mount Union, Pa., who, it is claimed, invented the portable iron section boats and devised the inclined planes over the Allegheny Mountains in the days of the old portage railroad, died in Pittsburg on Nov. 5th, at the age of 83 years. Mr Dougherty is credited with suggesting the route of the Pennsylvania Railroad, and in 1857 obtained a charter for the Sherman's Valley and Broad Top Railroad, which by act of Assembly was finally merged into the South Pennsylvania R. R. Mr. Dougherty was one of the most active and influential business men in central Pennsylvania. At one time he was considered a millionaire, but he died poor.

JOSEPH P. DAVIS, RUDOLPH HERING and ROBERT MOORE, members of the American Society of Civil Engineers, have entered upon their duties as experts to examine the plans proposed by City Engineer Samuel M. Gray, of Providence, R. I., for the sewage disposal of that city. As previously mentioned by us, these experts were appointed by President Henry Flad, of the Am. Soc. C. E. at the request of the City Councils of Providence.

American Society of Civil Engineers.

A meeting of the society was held on Wednesday evening, November 17, President Henry Flad in the chair. Mr. Edward B. Dorsey, M. Am. Soc. C. C., read a paper on "Irr gation," as practised in India, Spain, France, Italy, South America and the Pacific and Western States of this country. The author entered into the questions of the advisability, duty, cost, profits, crops, etc., of irrigated areas, and gave concise rules for rate of flow, character of ditch and distribution.

This paper clearly showed the importance of artificial irrigation to almost one-third of the area of the territory of the United States and at its close brought out an interesting discussion from members present, especially upon the point of riparian rights. In this connection it might be said that the author demonstrated, from exhaustive legal opinions, that the common, or old English law, regarding the rights of owners of land abutting on streams was entirely abrogated in all of the western states and territories except California and Nevada. The water of any stream, public or private, belongs absolutely to the party first appropriating and actually diverting it, regardless of ownership of lands further down the stream. The seeming injustice of this law was argued and severely commented upon.

Engineers' Club of Philadelphia.

Record of Business Meeting, November 6, 1886. President Washington Jones in the chair; twelve members and one visitor present. The following were elected Active Members of the Club: Messrs. Louis S. Wright, G. D. Chenoweth, Albert Millett, Wm. D. Hewitt, A. F. Harvey, Jr., H. A. Schofield, Amasa Ely and Arthur Marichal.

The Secretary presented, for Mr. W. E. Hall, a paper on Car Lubrication. What will be the result of the many attempts to improve the present condition of car lubrication, and to overcome some or all of the various annoyances—particularly that of the heating of journals and brasses—which are now connected with this important part of the transportation and motive power departments of railroads, is a matter of great interest.

The distinction between good and bad lubrication is simply a comparative one. Efforts should always be directed towards reducing the frictional resistance and wear of journals and bearings, upon which, with the quantity and quality of lubricant required per car per mile, depends the economy of the results.

The method of lubrication which is now used for passenger and freight car journals, is somewhat imperfect at its best, and much more so as carried out in railroad work. The principle of its action is that the material used in the boxes—whether fibrous, cotton or woolen waste—is of such a nature as to retain the oil, and, it is claimed, to draw it from the bottom of the oil-box to the journal with which the waste is in contact.

From the manner of attending to car oil boxes, it is found that the waste, from the frequent, but small, supplies of oil which it receives, does not reach its best condition—that is, become thoroughly saturated in the upper part, or that next to the journal, and able to retain a larger percentage of oil—until after it has made considerable mileage, and then it is that the lubrication of the journal obtained by this method is the most efficient. New waste, when put into boxes, will always make the journals reach a higher "running heat," which, although advantageous in increasing the fluidity of the lubricant and, therefore, decreasing the coefficient of friction, is yet objectionable in reducing the condition of lubrication to a more sensitive one, and one more likely to influence the production of hot journals. For this latter reason a low "running heat" of say seventy-five (75°) degrees Fahr., while giving somewhat higher frictional resistance, is preferable. It is always advisable to saturate new waste as thoroughly and as long as possible before placing it in car boxes, and to use waste, when repacking, that has seen more or less service, provided it does not contain sand or grit.

It will, then, be noticed, in the present method of lubricating car journals, that immediately after the box has been oiled the top of the waste is well saturated and all in good condition; but, in a short time, the waste in contact with the journal will lose what oil it may contain, by its falling to the bottom of the box, dissipation and leakage at the mouth and back.

While the box may contain abundance of oil at the bottom, the top of the waste, where it is desired the oil should be, is comparatively dry and inefficient. In this particular a mixture of woolen and cotton waste—about half and half—is found to give better service than either used alone. The woolen waste has the elasticity, and the cotton waste, while not absorbing as well, seems to keep the oil in the desired position better than the former. This is due to the cotton waste packing closer and tighter than the woolen waste.

Reliable experiments of Mr. Tower have shown that, with the several methods of lubricating, the comparative frictional resistances are:

Oil bath	1
Pad saturated with oil under and in contact with journal	6.48
Syphon lubricator	7.06

A consideration of these results, and their application to car lubrication, will follow at some future meeting.

Some discussion followed by Prof. L. M. Haupt, Mr. John T. Boyd and others.

Mr. Frank A. Hill presented a paper upon "Accidents in Anthracite Mines."

The impression that the proportion of fatal accidents in the anthracite mines is increasing, which has grown from the occurrence of recent disasters, is incorrect.

The duty of the Mining Engineer and Superintendent is to obtain the greatest yield at the least cost of money and life. The possible yield is more than the market can absorb, and the reduced cost of the coal at the mines shows the improvement in the economy of mining but this has not been accomplished at the expense of the lives of the miners. From 1875 to 1880 (6 years), there was an average of one death for every 98,692 tons mined, while from 1881 to 1885 (5 years), the average was one death for every 105,879 tons mined. This improvement is in the face of increased danger from gases, mine fires, roof-falls, quicksand, water, additional machinery, etc.

Roof-falls kill 44 per cent. of those who lose their lives in the mines.

Carelessness of the men is the greatest danger and the one hardest to meet. The importation of unskilled foreign labor joins ignorance with carelessness in swelling the death rate. Roof-falls, explosions of fire-damp, and careless handling of powder, furnish at least 60 per cent. of the deaths. In almost every case these accidents are due to the carelessness of the men: 10 per cent. is a very high estimate of the accidents for which officials are responsible.

From 1875 to 1885 (11 years) in Great Britain the average number of tons mined to one life lost was 130,555; in the anthracite region of Pennsylvania, 102,608.

There are no breakers in England, and as we waste in the breaker one-third of the material hoisted from the mine, 50 per cent. should be added to the shipment to obtain our true production. The English miner uses about ⅓ as much powder as the anthracite miner, so that ⅔ of the accidents from powder, as well as all accidents in the breaker, must be eliminated in a fair comparison. With these corrections made, the average number of tons mined in the Pennsylvania anthracite mines was 181,252 tons per one life lost, as against 130,555 in Great Britain.

The Secretary presented, for Mr. Geo. R. Henderson, a paper on the "Efficiency of Locomotives and Resistance of Trains." The efficiency of locomotives depends, first, upon the proportions of the engine, and second, upon the grade, curvature, etc., of the road. From the proportions, etc., of the engine we can determine the effective tractive power, and then, taking the proper formulæ for resistance on grades, etc., and equating the two, we derive an equation by the resolution of which we obtain the necessary values to determine the load a given locomotive will haul on a certain road, or, the load being known, to proportion the engine. These formulæ and tables are given in the paper.

The Secretary presented, for Mr. Herman Haupt, Jr., a description of the St. Paul Ice Palace, illustrated by photographs and prints. The structure was of rectangular cruciform ground plan, 180 ft. x 154 ft., with principal tower 106 feet high, surrounded by other towers, etc., giving very beautiful and complete architectural character to the building. The principal entrance was under a gothic arch of 10 feet span and 25 feet high. The blocks of which the palace was constructed, were 22 ins. x 44 ins. x 20 ins., the latter being the thickness of ice. They were marked out on the surface of the ice on the Mississippi river, and sawed at once to these dimensions, which were unchanged afterwards, except where, in round towers, etc., some trimming with axes was required. The blocks were raised in place by ice-tongs and tackle, operated by horse power. The blocks in walls and arches were cemented with water, which at the existing temperature, froze almost immediately. The structure was reared in forty-two days. It was the conception of Mr. George Thompson, of St. Paul.

HOWARD MURPHY,
Secretary and Treasurer.

UTILIZING OLD TIES.—C. Benson, of the Netherlands State Railroads, proposes to utilize old railroad ties by sawing them in two, and reversing the pieces so as to bring the usually sound middle portion under the rails. He joins these pieces by angle-iron upon which the rails rest so as to prevent further cutting. As the compound tie has four end faces, the resistance to lateral movement is great. See Transactions of the Inst. C. E.: Vol. lxxxvi, page 31.

CORRESPONDENCE.

Sugar Mortar.

NEW YORK, Nov. 11th, 1886.

EDITOR ENGINEERING NEWS:

In a recent number of ENGINEERING NEWS you refer to the use of sugar in mortar, quoting from "The Colonies and India," accepting the statement *cum grano salis*.

Sugar has been used in India in combination with lime from time immemorial, and reference has been made to it by standard authorities.

In "Engineering Notes by Frank Roberston, F. R. Astron. Society, late first Lieutenant Royal Engineer, and Civil Engineer Public Works Department in India. London, 1873, page 146, we find.

"The admixture of the coarsest sugar called Goor in Bombay, and Jagiri in Madras, in the proportion of one pound Jagiri to each gallon of water with which the mortar is mixed, add one-half to its breaking strength and double its cohesive strength.

Again page 149: "The plaster may well be tempered with sugar in the water; the first coat may be ⅝ inch thick; the second coat has no sugar as it would tinge the color."

Dr. Ure's Dictionary of Art, and Manufacturers edition, 1867, page 803, states as follows: "That syrup possesses the property of dissolving the alkaline earths, lime, magnesia, etc., was demonstrated long ago by Mr. Ramsey of Glasgow; he says that syrup is capable of dissolving half as much lime as it contains of sugar."

It is probable that the effect of sugar on lime may be that the sugar dissolves it. That it adds a certain amount of strength by its own crystalization. That it dries less rapidly, and the hydration and absorption of gases is more complete. By the absorption of nitric and sulphuric acids from the atmosphere an insoluble oxide of lime may be formed.

Experiments made by me some years since did not indicate that sugar was of great advantage in combination with the best qualities of Portland cement.

JOHN C. GOODRIDGE, JR.

[Since the above publication of the original note referred to in Mr. Goodridge's letter, we have in part published similar evidence as to the use of sugar in mortar but give his letter as throwing some further light upon this subject. ED. ENG. NEWS.]

Surveying, by Prof. J. B. Johnson.

Washington University, Department of Civil Engineering.

ST. LOUIS, Nov. 12, 1886.

EDITOR ENGINEERING NEWS:

In reply to your generous review of my book on Surveying in your issue of the 6th inst. I should like to offer a few remarks on the subject of text-books for the use of engineering students. It has long been my fixed conviction that the Department of Surveying should be greatly enlarged in engineering schools. Every civil engineering graduate should have a fair working knowledge of the theory and practice of the various kinds of surveys which fall to the lot of civil engineers to perform. There has heretofore been no book on this subject which came anywhere near covering the ground, or of giving the most approved methods. My book is an *effort to do this*. But a text-book cannot be an exhaustive treatise. It should give only the essential outlines in each kind of work, leaving the instructor to fill in with oral instruction, where he finds it necessary. Many things, for example, the reading of verniers, can be much better taught from the vernier itself than from a cut and a written description. It has been assumed the reader of this book had access to instruments and was guided by a competent instructor. It has been my experience that the subject of surveying, as treated in some text-books, loses most of its interest to engineering students from the very prolix and elementary manner with which the subjects are treated. The books are *written down* to a grade of comprehension and mathematical intelligence far below the average sophomore in our engineering schools. I have tried to avoid this error and may have erred in the opposite direction, but such omissions are readily supplied by the instructor. For example, many problems with the chain, as for passing obstacles, setting out perpendiculars, parallels, etc., instead of being worked out in great detail are given as "problems" for the student to solve with just sufficient hint of the method to enable those, who are familiar with plane geometry to work it out themselves. If my reviewer will turn to page eleven he will find sixteen such problems. The subject is not overlooked as he supposed.

In the matter of leveling, I have had perhaps as extended an experience as any engineer in America (with possibly one or two exceptions) and I gave all that I thought was *necessary* to make a scientific and

expert leveler. All matter so elementary as to be considered superfluous was omitted. The barometric formula given is practically that given by the U. S. Coast Survey, (Report of 1851). The *derivation* is new but the formula is the most approved one on record. I did not give the degree of accuracy attainable by barometric leveling because I did not know it. If my reviewer can enlighten me I should be under great obligations to him.

As to working instructions for the various and multitudinous cases arising in Land Surveying. I did not consider them as properly belonging in a school text-book. These methods are matters of law, and court decisions, and I knew they had been well considered in Bellows and Hodgman's hand-book, and it would not be wise to include them in mine. Very few civil engineers have to do this kind of work, and if they do they can readily procure one of the hand-books giving such information. My book was already too large.

The chapter on "Railroad Surveying" is just what it pretends to be—a description of the general surveys accompanying a railroad project, for location and right of way, but excluding the running of curves, and other matters treated in detail in all field-books. The chapter on "Earthwork," also was intended to supplement the field-books, rather than to replace them.

My reviewer has evidently never had to plot a large area on a map, or he would see very clearly the significance of the chapter on that subject. He also gives a new rule for the height of an observing station. If his rule were true, it would indeed be a most convenient one: but until the earth changes its form very much from that which it is generally supposed to have, I would not recommend to make "the height of the tower in feet three-fifths of the distance in miles." Neither, I think, would he upon second thought.

Finally, I will say that my book is not so far from what I would have it as my reviewer assumes. It is certainly a radical departure from established precedents, but I think no less of it for that. I have had constantly in mind the proper putting of graduate engineers for the duties which await them, and I believe the book is well adapted to fit into the average course in engineering in American schools along with the text-books now used in collateral subjects. The feature which I expected ENGINEERING NEWS to especially note and commend, was the preparation of an earthwork table for computation by the prismoidal formula directly such a table is given, and it was prepared partly in accordance with an editorial on this subject in your issue of July 17, 1886. So far as I know, it is the only single table giving exact volumes by the prismoidal formula, from end section data. Usually, the volume by mean end areas is given by one table, and then a prismoidal correction by another. My table gives the prismoidal volume at once, and this is what you advocated so strongly. And yet no especial mention is made of this feature in the review. I hope you will pardon my calling your attention to it.

Text-books are not usually furnished with an index, but one will be appended to future editions.

Thanking you for the courtesy you have shown in your extended notice I am,

Yours very respectfully,

J. B. JOHNSON.

Notes from Italy.

From our own Correspondent.

TURIN, Nov. 1st, 1886.

The iron and steel works of Terni may now claim to rank amongst the most important of Europe, not only on account of their size, but on account of their being provided with plant and machinery of the most modern description for the production of Bessemer as well as of Siemens-Martin steel. The manufacture of steel rails has only been commenced at these works during the present year, the first rail made in Italy being rolled last April. The manufacture of steel armor plates for the Italian navy has also been commenced, the first plate being turned out last month. The company is at the present moment in position to turn out from 130,000 tons to 140,000 tons of steel annually. Connected with this company which comprises the steel works and iron foundry of Terni, the first with a capital of eighteen millions of lire, and the second three millions, are the mines, iron works and blast furnaces in Val Trompia (Province of Brescia), with a capital of three to four millions; the blast furnaces and iron works at Civita Vecchia with a capital of about four millions; the lignite mines at Terni and Spoleto, with a capital of between three and four millions of lire. Taking into consideration the favorable situation of this establishment, the abundant supply of water which furnishes motive power, compressed air, etc, the low prices at which the lignite can be delivered at the works, and the excellent quality of the Elban and Brescian ores, there is every reason to anticipate that the Terni works will in the future be able not only to hold their own in the Italian market, but prove a formidable competitor to English, Belgian, French and German manufacturers, if not in their own markets, at all events in South America and the East.

Messrs. Ansaldo & Co., of Sanpierdarena, have just completed two heavy forgings, weighing several tons each for the steam ports of two torpedo rams now building in the Government yards. This firm has at the present time in hand several marine engines for the Italian navy.

The heavy rains during the last few days have caused serious floods in the North of Italy. On the morning of the 27th ult. a serious accident occurred at the new bridge, now in construction across the Po at Casale, the staging used for sinking the last of the five iron caissons for the foundation of the piers being suddenly washed away, one of the engineers and eight workmen being carried away by the current, three men unfortunately were drowned but the engineer and the five others were rescued. The iron caisson weighing about fourteen tons, which was already in position for being sunk by compressed air, was transported by the force of the stream for a distance of 150 metres, partially destroying the temporary wooden bridge, 260 metres in length, of which about half has since been carried away. The staying at the third pier has since been carried away, but no damage has been sustained by the pier itself.

The Mediterranean Railway Company has 1,200 trucks in construction at the present time, and according to a statement made by the general manager, it will be necessary to provide 1,800 more by next spring, in order to satisfy the requirements of the steadily increasing traffic. It is evident that so large a number cannot be furnished by the railway workshops or by private firms in Italy, and it is highly probable that important contracts will be given to foreign makers.

A Genoese firm are about to fit out a steamer of 3,000 tons, as a floating exhibition of Italian products which it is proposed will visit various ports in the West Indies and Central America, with a view of opening new markets for Italian goods.

In the recently published report of the Italian inspector of mines, Sig. Pellati, it appears that the total production of petroleum in this country (Italy) was only 397 tons, to the value of 135,452 lire during 1884, as compared with 225 tons to the value of 58 387 lire in 1883, and 183 tons to the value of 86,844 lire in 1882. This production, the report remarks is insignificant, as compared with that of the United States and the Caucasus, the production of the former amounting to 3,103,000, and the latter to 1,430,135 tons in 1884.

The proposal made to the Italian government by a syndicate of noted capitalists for the improvement of the port of Civita Vecchia, has been reported upon favorably by the Superior Council of Public Works. The project comprises, the enlargement of the existing floating station to an area of 70,000 square metres (17½ acres), and with a length of 1,200 metres (3,936 feet) run of quay walls, with sufficient depth of water, as to allow vessels drawing 8 metres (26' 3") to come alongside. The maritime station would be situated on the east side, and to be systematically laid out with lines of rails on the quays and provided with machinery and appliances of the most modern description for loading and unloading ships. On the north and north-west side will be erected sheds and warehouses for the temporary reception of goods or of such merchandize as is not forwarded direct to its destination, as well as that in bond. The total cost of this work is estimated at ten millions of lire. The trade of Civita Vecchia has increased seven-fold since Rome became the capital of Italy, the total movement being 70,000 tons only in 1869, and 350,000 tons in 1885. The project for the irrigation of the plains of Stoli and Monte Corvino by a canal to be derived from the river Sele was laid before the Minister of Public Works recently. The cost of this work is estimated at 4½ millions of lire.

Although not an Italian work, the construction of a canal across the isthmus of Corinth, cannot fail when opened to have some effect upon Italian commerce, as by this route the distance between the principal ports of this country, and the Piraeus will be considerably shortened, viz.: Genoa, 12.2 per cent.: Venice, 18.4 per cent., and Brundisi, 32.4 per cent., whilst the distance from Marseilles will be shortened by 11 per cent. The concession for the construction of a ship canal across the isthmus was granted in 1881 by the Greek Government to General Türr, a Hungarian, who accompanied Garibaldi to Italy, and the first sod was cut by King George I. on the 4th of May of the following year. The idea of piercing the isthmus of Corinth originated in ancient times, and under the Cæsars the works were actually commenced. The route of the canal now being made by the Société International du Canal Maritime de Corinth follows as nearly as possible the course indicated by the traces of Nero's canal, which is 6,342 metres in length (nearly 4 miles), with a maximum depth of cutting of 78 metres (255¾ feet) in the central part. The cross section of the canal will be the same as that of the Suez canal, viz.: a bottom width of 22 metres (72 feet) and a depth of 8 metres (26¼ feet). The total quantity of earth work is estimated at 9,130,000 c. metres. The average quantity excavated daily is between 6,000 and 7,000 c. metres, and it is anticipated that this will soon be increased to 8.000 c. metres, so that by the end of the present year, 5,000,000 c. metres will have been excavated. It is anticipated that by the end of next year the bulk of the work will be completed so that in 1888 the canal will be opened for traffice. At the present time, a narrow canal, 5 metres deep, is being excavated, to allow the passage of the steam dredges by which means the canal will be excavated to its full width, and deepened. The railway works and road are nearly finished. The west entrance at Poseidonia will be protected by two converging jetties, forming a harbor; the northern jetty is already in a forward state. The east entrance at Isthmia, will be protected by a single jetty on the north side. There will be no locks on the canal, as the variations of the sea level are very slight; the only works of importance are two iron bridges of 262 feet span, which cross the canal at a height of 170 feet above the water level, to carry the Piraus and Peloponesus Railway and main road over the canal. As the length of the canal is so short, the transit of vessels through it will be effected without the aid of passing places, as on the Suez canal. It is estimated that the transit on the Corinth canal will amount to 4,646 000 tons annually. A toll of 1 franc per ton will be charged on vessels coming from Adriatic, and ½ franc per ton for those coming from Mediterranean ports, and 1 franc per head for passengers from any port.

Experiments for the electric lighting of the Piazza Colonna at Rome were made last week with satisfactory results, but the installation for the lighting of the Piazza Monte Citorio and the Piazza Venezia are not yet completed, and a date for the official inauguration of the light in the city has not yet been fixed.

Permission has been granted to the Italian Edison Company to light the Piazza del Plebiscito as an experiment, the water power being furnished free to the company from the high pressure water mains. It is also proposed to light the theatre of San Carlo and the Royal Palace by electricity. The installation for the electric lighting of Palermo is also being pushed forward. The machinery and material is all on the spot, with the exception of an engine of 80 H. P., which has been shipped from England.

The electric lighting of Turin is still at a standstill, notwithstanding that more than a month has elapsed since experiments were made in some of the principal streets and piazzas.

LITERATURE.

Shoppell's Modern Houses.—Vol. 1, No. 4, Oct. 1886. The Co-operative Building & Loan Association, 191 Broadway, New York. Price $1 per number.

The above is an illustrated architectural quarterly, issued on a somewhat novel plan. The purpose of the association is to illustrate in this publication, by very well executed perspective elevations and by plans, types of dwelling houses of varying cost. If an intending builder finds something that suits him among these, he is supplied with the working drawings by the association at about *one-quarter* the cost of the usual architects' fees. For a special design the charges would be about the same as those adopted by the American Institute of Architects. The cost of construct on given in each case is stated to be based upon actual figures and in accordance with a schedule of item prices published. In the present number the prices for working plans range from $15 to $250 for the plans shown. The illustrations of houses show over fifty separate plans, which are very well drawn and well described. The scheme commends itself to those intending to build, and in any event the quarterly would be a valuable aid in selecting plans.

The Magazine of Art for October.—"Hermes," after the painting by W. B. Richmond, in the last Grosvenor gallery exhibition, is the frontispiece of the *Magazine of Art* for October, and is followed by a fully illustrated paper, the IV. on "Current Art," by the editor. An interesting paper gives us "More about Old Charterhouse," with characteristic illustrations. Stanley Lane Poole writes on "A Venetian Azzimina of the 16th Century," and R. Penderel-Brodhurst revives some old "Royal Academy Scandals." R. J. Charleton describes with a lively appreciation of its many beauties, the pretty little fishing village of Cullercoats, while R. Jobbing proves the truth of these descriptions with his pencil. The pictures painted for Thomas Mackin for his numerous literary enterprises are carefully described and the story of their origin told by Alfred Beaver. The story of "La Bella Simonetta" is told in the series on "The Romance of Art." Coming down to modern times Claude Phillips describes the work of the late Paul Baudry, and his paper is illustrated with engravings from Baudry's best known paintings, and also with a page portrait of the distinguished artist from the bust by Paul Dubois. "Art in Ancient Rome" is laid before latter-day amateurs by Wm. Holmden in an illustrated paper. There is a page engraving from the painting "The Mountain Pass," by A. Wierzs-Kowalski: this is followed by an account of the French and Dutch pictures in Edinburg, and the department of American and foreign art notes.—*Cassell & Company, Limited, New York, 35 cents a number, $3.50 a year in advance.*

Recent Investigations Concerning the Dry-Rot Fungus (Merulius Lachrymans.)*

BY DR. K. B. LEHMANN, OF MUNICH.

This fungus does not occur either on the growing timber or upon decaying wood in the forests themselves; it belongs entirely to the dwellings of civilized communities, and it is so susceptible to the influence of air and light and of heat and cold, that it could scarcely exist in the forests of Northern Europe. It is very difficult to say where it originally came from, but at present it is introduced solely by the use of infected timber from old buildings; or possibly the spores, four millions of which would only occupy the space of a cubic millimetre, may be conveyed into new houses on the cloth s, boots, or tools, of the workmen. Hitherto all attempts to cultivate the fungus from its spores have failed, and Professor Poleck, of Breslau, is the first observer who has succeeded in producing a vigorous growth of the merulius on fir timber. The mode of growth is explained by reference to illustrations, and certain peculiarities in the structure of the fungus which have been found in no other vegetation of the same kind, more especially the development of little side branches (*Aestchen*) from the buckle-cells are pointed out. Professor Hartig has shown that the fungus throws out broad tubular chains of cells, apparently destined for the conveyance of water to a distance; and he has proved that the mycellium of the merulius offers far greater resistance to drying influences than that of the common mildew. He states further that the fungus can only assimilate the mineral matter of the cell-walls of the timber when it is in contact with it, and that it is unable to extract the inorganic constituents of the wood cells from any distance. The component matters of the cell-walls—coniferin and cellulose—are absorbed, but the tannin and the wood-gum or resin appear to remain unattacked by the fungus. The albuminous matters contained in the cells are consumed, but where the supply of albumen is scanty, the merulius appears to prey upon the decaying protoplasm of former growths of the fungus, so that in timber which has been strongly exposed to attack, scarcely any traces of the mycellium are distinguishable. Analyses are given of the mycellium and of the spores, from which it would appear that while the barren mycellium is rich in insoluble phosphates of iron and of lime these salts are wanting in the spore-beds, and are replaced by enormous quantities of phospate of potash. It was in consequence of the results of these analyses that Professor Poleck was induced to examine the ashes of timber felled in the winter and in the summer, and that he was led to assert that the summer-felled timber affords a better supply of nourishment to the fungus than that felled in winter, the former, as will be seen from the table, being five times as rich in potash, and eight times as rich in phosphoric acid as the latter:

One Hundred Grams of Sound Pine Timber Dried at 110° Centigrade.

Yield.	Taken from a pine felled in the winter.	Taken from a pine felled in April.
	Grams.	Grams.
In ash	0.19	0.22
Percentage soluble in water	7.89	24.08
Containing potash	2.67	11.57
" phosphoric acid	0.76	5.85

Experiments which confirmed this view were conducted with blocks of timber enclosed in casks. In opposition to the theory of Poleck, a number of experiments carried out by Hartig are recorded. In the first place, Hartig shows that at the end of April the sap has not risen in the timber, and that no mineral matters can have been stored up in the wood-cells which were not present at the beginning of the winter; and that true summer-felled timber must, if anything, be poorer in mineral salts than that felled in the winter time. The analyses he made confirm this view, for he found in the ashes of the winter wood 8.42 per cent. of phosphoric acid, and only 5.89 per cent. in the summer wood. Moreover, the experiments of Poleck pointed to a necessity for phosphoric acid and potash to encourage the growth of the fungus while Hartig insists only upon the presence of ammonia or potash-salts, and makes no mention of phosphates.

Hartig's practical experiments, which were carried out in a specially constructed cllear, were made both with pine and fir timber felled for the purpose. Small specimens of each kind of wood were enclosed along with wood containing live mycellium of the merulius in glass vessels, and also in contact with various materials, such as garden mould, sand, coal dust, ashes, etc. They remained thus enclosed from the 8th of July until the 20th of December, and the condition of each sample was examined on the 6th of August and on the 11th of September. At the end of the experiment the loss in weight of the sound and of the infected wood was noted, also the loss in bulk, and the amount of moisture present in each specimen. These observations are set forth in numerous Tables, the general result being that both winter and summer felled damp fir and pine (the different kinds of timber behaved alike) lost equally in weight. When, however, dry winter-wood was contrasted with wet winter wood the results were astonishingly different. In the case of fir, while the dry wood lost 11 per cent. in weight, the wet wood, as might be expected, lost 23.1 per cent.; but in the case of pine the loss on the dry wood was 13.3 per cent., while on the wet wood it was only 13 6 per cent. Comparative experiments with the heart timber in fir and pine as contrasted with the outside planks showed that while in fir the heart was destroyed more rapidly than the outer layers, the reverse was the case in pine. Very unexpected results have been obtained when the wood was in contact with the various substances already enumerated; and it would seem that clean sand is a worse material for filling in between the joists than a mixture of sand and plaster, while dry rubbish from old buildings takes a much better place than coal-dust.

Numerous observations are given of the loss of the timber in bulk and weight, and of the nature of the changes which arise from the growth of the dry rot. On the suoject on the injury to health caused by the fungus in houses, the present opinion is that positive proof is wanting. A long list of precautionary measures follows, setting forth the best known means of combating the spread of dry rot; and the author considers the effect of the different specifics and preservative solutions, of which creosote oil appears to be the best. Tests of various kinds with preservatives are recorded, but a general warning is given against trusting to any of these proposed remedies.

* From "Abstracts of Papers;" Inst. C. E.

Words of Wisdom from P. T. Barnum.

Addressing a body of business men at Bridgeport, the other day, P. T. Barnum said: "You do not, any of you, advertise enough. You ought to use printer's ink every day. You are asleep and want your business to run itself. Standing advertisements in a paper command confidence. The man who for a year lives in one community and leads a reputable life, even though he be of moderate ability, will grow in the confidence and esteem of his fellows. On the same principle a newspaper advertisement becomes familiar in the eyes of the reader. It may seldom be read, still it makes the name and business of the man familiar, and its presence in the columns of a paper inspires confidence in the stability of its enterprise.

WATER.

THE firm of Comegys & Lewis, of New York, have just obtained the franchise for the following places and classes of work:—To erect water-works for Ashtabula, O.; water and gas-works for Chillicothe, Missouri, and water-works for Nebraska City, Nebraska. Work is to commence upon all of these in the spring of 1887.

A SOUTH AUSTRALIAN RESERVOIR AND DAM.—The *Indian Engineer* reports the present construction of a reservoir in South Australia, intended to store rainfall and the waters of the Beetaloo springs for the use of Gladstone and neighboring towns. The reservoir will cover 88 acres, with an average depth of 60 feet and contain 700,000,000 gallons. The cost is estimated at $1,000,000. The dam building in connecting with it will be on a radius of 1,323 feet; width at bottom, 82 feet, at top, 14 feet; height, 105 feet; length on top, 560 feet; estimated amount of stone masonry, 33,000 cubic yards.

CAMBRIDGE, N. Y.—The water-works have recently been completed. The system is the combined pumping and gravity; there are two reservoirs, one 175 feet above the village, with a capacity of 4,000,000 gallons, is used for fire protection only; the other, 50 feet below the village, is for domestic purposes; the water from this reservoir has to be forced up to the village, for which purpose there is a 12 feet, high breast, wheel which develops sufficient power to pump 70 000 gallons per 24 hours, when this amount is not consumed the balance is pumped to the upper reservoir. The lower reservoir is formed by an earth bank enclosing an acre of land, the springs from which have an aggregate flow of from 2,0 0.000 to 3,000,000 gallons per day. The upper reservoir, which is fed by a stream and springs, is 2½ miles from the village and the 8-inch supply main is joined about half a mile from the reservoir by the 6-inch force main from the lower reservoir, this latter main being half a mile long: at the junction is placed an automa ic valve which is normally closed so that no water is drawn from the upper reservoir; in case of fire, as soon as a hydrant is opened and more water taken than the pumps are supplying, the decreased pressure causes the valve to open, giving the full pressure from the upper reservoir; this operation requires from 1½ to 2 minutes. There are six miles of 8-inch, 6-inch and 4-inch cast-iron mains; the service pipes are of galvanized iron: there are 35 Ludlow double-nozzle hydrants and two drinking fountains, for which (with the exception of one hydrant) the city pays $1,350 per annum; the exception is a private hydrant for which the company receives $40 per annum. The original contract was for 30 hydrants at $40 and the fountains at $25 per annum, and four more were added at $.5 per annum.

The water is soft and pure and the consumption is small, but is estimated to reach 45,000 gallons per day in less than two years. No meters are used. The population is about 1,600. The pumps, wheel and machinery were built by S. Adams & Co., Rome, N. Y.; and the valves were supplied by the Eddy Va ve Co., Waterford, N. Y. The pressure in the village when the automatic valve is closed is due to a head of 50 feet. The plans and specifications were prepared by C. W. Knight, Rome, N. Y. and C. W. Hawley was constructing engineer; the works were built by Adam Miller & Co., Rome, N. Y., and cost about $40,000. The works are owned by the Cambridge Water-Works Co., which issues $25,000 bonds and $15.000 stock, paying 5 per cent. (half yearly) on the bonds; President, Wm. McKee; Secretary, C. F. Hawley.

Contracting.

Stone.—The following bids have been received by Capt. W. H. Bixby, U. S. Engineer, Wilmington, N. C.: W. A. Martin, Wilmington, $1.52½ per ton; George J. French, Wilmington, $1.80; B. G. Bailey, New York City, $1.94; W. F. Haigh, New York City, $2.16½; W. H. Trump, Philadelphia, $2.23.

Dredging.—The following bids have been received by Capt. W. H. Bixby, Wilmington, N. C.; Cape Fear river, N. C.; W. H. W. Morris, New York City, 14.9 cents per cubic yard, measured in the scow: Ross & Sanford, Jersey City, N. J., 15.2 cents; American Dredging Co. Philadelphia, Pa., 15.5 cents; Rittenhouse Moore, Mobile, Ala., 15.5 cents; National Dredging Co., Wilmington, Del., 15.5 cents; Morris & Cummings Dredging Co., New York City, 15.75 cents; Frank C. Somers, Philadelphia, Pa., 15.9 cents; Baltimore Dredging Co., Baltimore, Md., 16 cents; George C. Forbes & Co., Baltimore, Md., 16.5 cents.

Georgetown Harbor, S. C.; W. H. Morris, New York City, 16 cents per cubic yard in the scow; Rittenhouse Moore, Mobile, Ala., bid withdrawn unopened.

Sewers, Street Work and Pipe.—The following proposals were opened November 18 at the Department of Public Works, New York City: Sewers; 1) 143rd street, John Slattery, $5,026.25; Thomas Murray, $4,208; J. J. Montgomery, $4,693; John S. Kelly, $3,912.50 P. M. Sheehey, $4,225.25; J. W. Phelan, $4,094.25; J. A. Devlin, $4,139.35; J. J. Jones, $5,021.25.—(2) Madison avenue, John Slattery, $10,192.50; Thomas Murray, $8,-560.50; Joseph Moore; $10,920; J. J. Jones, $10,702.50; John McKim & Son, $8,603 40.—(3) 142nd street, C. Smith $5,887.50; Michael Fay, $4,781.50; John Slattery $5,330; Thomas Murray, $4,100; P. M. Sheehey, $3,717 50; Joseph Moore, $5,310; J. A. Devlin, $3,844.25; J. J. Jones, $5,335.—(4) 97th street, Joseph Moore, $4,730.—(5) Lexington avenue, Joseph Moore, $6,410; J. J. Jones, $5,900; John McKim & Son, $6,697.50.—(6) 91st street, John Slattery, $8,232.50; P. M. Sheehey, $8,148.75; Joseph Moore, $11,170; J. J. Jones, $9,495; John McKim & Son, $7,538.05

Regulating, grading, curbing and flagging.—(7) 90th street, J. J. Farley, $7 929.37; Thomas O'Maley, $6,-217.55; Thomas Crimmins, $9,510.10; Michael Egan, $8,561.85; J. M. Slattery, $10,429.65; John Slattery, $8,-072.60; Wm. Kelly, $8,600.12; John Brady, $8,281.07; P. McInerny, $10,468.23.—(8) first new avenue west of Eighth avenue, B. McMahon, $17,414.95.—(9) Manhattan avenue, D. W. Moran, $2 362 10; Thomas Murray, $2,-498.90; John Slattery, $2,800.50; P. McInerny, $2,478.10.

Cast-iron water pipes, branch pipes and special castings.—(10) McNeil Pipe Co., $13,675; Camden Iron Co., $14,700; Warren Foundry & Machine Co., $12,850.

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials,

WHOLESALE PRICES.

New York, November 18, 1886.

IRON.

STRUCTURAL IRON.			
Angles		2.15c	@ 2.25c
" steel		2.45	@ 2.60
Tees		2.50	@ 2.60
Beams and channels, American		3.00	@
Tank plates		2 25	@ 2.35
Shell plates		2.50	@ 2.60
Steel plates, Tank		2.70	@ 2.75
WROUGHT-IRON PIPE, PITTSBURG.			
Butt welded, black	Discount		46
" galvanized	"		30
Lap welded, black	"		52½
" galvanized	"		35
Boiler tubes	"		45
RAILS.			
Steel (large lots at mill)		$34.00 @	$35.00
Old rails		22.25 @	23.00
Old rails, steel		22.00 @	23.00
R R. spikes		2.15c @	2.20c
R R. spikes-plates		1.70 @	1.90
R R. track bolts, square nuts		2.50 @	2.75
Barb-wire fencing, galvanized		3.85 @	3.90
" painted			4.00
Corrugated iron			
Nails			
Iron, per keg		1.95 @	2.00
Steel do.		2.10 @	2.20

METALS.

COPPER.		
Lake Superior	11.50 @	11.90
Other Brands	10.37	
LEAD.		
Com. Domestic	4.00 @	4.25
Lead Pipe	.06½c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.50 @	5.70

BRICK.

Cargoes (afloat)		
Choice Brands	7.75 @	8.00
Haverstraw, per M.	7.00 @	7 75
Fishkill	7.00 @	7.25
Up-River	6.75 @	7.00
Jerseys	6.25 @	6.75
Long Island		
Pale	4.75 @	5.00
FRONTS.		
Croton, red	13.00 @	15.00
" dark	13.00 @	15.00
" brown	12.00 @	14.00
Philadelphia pressed	24.00 @	25.00
Trenton "	24.00 @	25.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	85.00 @	130.00
" American	80.00 @	120.00
Fire brick	25 00 @	55.00
" American, No. 1	30.00 @	35.00
" No. 2	25.00 @	30.00

ASPHALT.

ROCK.		
French, per ton	$22 00 @	25.00
German	15.00 @	20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50 @	$3.00

LIME.

Rocklock Cement Co.'s Ground	.80	
Rockland, common per bbl	1.00	
" finishing	1.20	
State, common	.85 @	.90
" finishing	1.05 @	1.10
Kingston, ground	.90	
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95 @	1.00
" " No. 2 "	0.75 @	0.85
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00 @	1.35
" Belleville, N. J. "	0.75 @	1.35
Granite, rough	0.45 @	1.25
Common building stone per load	2.00 @	3.00
se stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00
oncrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	5 00 @	6.00
Green "	5.00 @	6.00
Red "	10.00	
Black Penna. (at New York) "	3.50 @	4.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @	20.00
Choice "	65.00 @	70.00
Tally plank, 1¼ in. 10 in. dres'd, each.	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	14.00 @	18.00
HEMLOCK, Boards each.	.14 @	.16
Joist, 2½ × 4 to 4 × 6 in	.16 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2¼ in	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.25 @	2.30

PAINT.

Lead, white, American dry per lb	.04¾ @	.06½
" " in oil pure "	.07 @	.07½
" English, B. B. in oil "	.08½ @	.08¾
" Red, American "	.06½ @	.07
Litharge "	05½ @	.06
Venetian red, American "	.01 @	.01¼
Indian red "	.08 @	.10
Vermillion, American lead "	.10½ @	.11¼
Paris green "	.15 @	.18
Umber, Amer. raw and powdered per lb.	.01¼ @	.01½
Drop black, Amer. "	.07 @	.13
" " Eng. "	.11 @	.13
Chrome green "	.10 @	.25
Oxide zinc, American "	.03½ @	.03¾
" French "	.05½ @	.07½

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MAYERSTEIN:		
Hanover Port.and	$2.60 @	$2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25 @	2.50
Fewen	2.75 @	2.50
BROOKS, SHOOBRIDGE & Co.:	2.45 @	2.60
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40 @	2.75
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50 @	2.75
K. B. & S. " "	2.25 @	2.50
Stettiner, German	2.65 @	2.85
Lagerdorfer, "	2.45 @	2.75
Fleve. A 1, Belgian	2.35 @	2.50
Roman	2.75 @	3.00
Keene's Coarse	4.75 @	5.50
" Fine	7.75 @	8.50
" Superfine	8.50 @	10.00
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15 @	2.45
EMIL LENZ, New York.		
Stettin Portland	2.35 @	2.55
Fire-proof	1.75 @	1.95
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20 @	2.40
Improved "Union"	1.25 @	1.50
Union	1.10 @	1.20
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35 @	2.85
K. B. & S.	2.25 @	2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90 @	3.25
UNITED STATES CEMENT CO.:		
English Portland	2.25 @	2.40
German "	2.10 @	2.15
Standard	1.80 @	1.65
Windsor and Improved Rosendale	1.00 @	1.10
UNION AKRON CEMENT CO.:		
Akron "Star" brand	1.00 @	1.10

MARKET SUMMARY.

The brick market has been firm, free arrivals and steady sales are reported, Fishkills being particularly in request at $7.00@$7.25 per M., other Up Rivers $6.75@$7.25 per M. Haverstraws sold at $7.00@$7.25 per M. for Seconds, $7.50@$7.75 for Firsts and Choice at $7.75@$8.10; Jerseys are quoted at $6.25@$6.75, and Pale are of ready sale at $4 75@$5.00 per M. Philadelphia and Trenton Face brick $24@$25 00 per M. on pier. Rosendale Cement is in active demand, and no first-class brand can be bought for less than $1.10 per barrel. Portland Cement steady at $2.15@$2.35 per barrel ex ship, with occasional breaks in prices for large or specially desirable orders. Lime is unchanged in value, with a good demand at $1 00 for common Rockland, and $1.20 for finishing. Hair continues scarce but no change in quotations has yet been made. Cattle sells at 21c.@22c. per bushel, and Goat at 32c @36c. Plaster is selling in fair quantities at $1.20@$1.25 per barrel. In the Lumber Market we hear of some activity. Spruce is a trifle firmer and $14.00 per M. would be a bottom figure for poor sized schedules, with $16.50 quoted for desirable invoices, and $18.00 for special heavy orders. Hemlock is in considerable demand at $12.50@$13.50 per M. for timber, with a likelihood of a rise in value. Boards 14c.@15c. each. Yellow Pine continues to sell at $18@$21.00 per M. Lath has arrived recently in large quantities but consignees have found no difficulty in placing all their receipts at $2.25 per. M. with occasionally $2.30 for small parcels. One firm reports sales of over 7,000,000 at these figures during the past week. Paints continue to sell at old quotations, Linseed Oil has again sold at 36c. for Western, and 39c. per gallon for City, with an addition of 3c. per gallon if boiled, Turpentine not quite so firm and 37c. best figure now obtainable. Lead rather quiet and price now quoted at 4½c. for domestic. Tin is firm at 22.50c. for Straits, 23c. for Banca, with little speculative business. Tin Plate is without activity, but prices remain as last week. I. C. Charcoal one-half cross assortment, $4 60@$4.65 for Allaway and $5.15@$5.20 for Molyn grade, for each additional X add $1.00 and $1.50 respectively. The Hardware Market shows no special activity and purchasers are conservative, buying only what is required for actual necessities; no positive changes in prices are reported, except in Barb Wire, which is firmer, and selling at 3.90c @4c. according to quantity. Nails are in but moderate demand, and prices continue at late rates of $1.95@2.00 per keg, for 10d.@60d. with discount on very large orders.

BUILDING ITEMS.

Mr. Wilbur S. Knowles, 189 Broadway, reports plans on hand for a $6 000 cottage, to be built at Jacksonville, Florida, for Mrs. M. E. Christopher, also a cottage to be built at a cost of $7,000, at Glen Ridge, for Mr. T. C. Harvey.

The contract for the additions and alterations to Claussens Brewery, which will cost about $50,000, has been awarded to J. & L. Weber.

Mr. George E. Harney is preparing plans for the New York Real Estate and Improvement Company, for alterations to be made to No. 53 Cedar street, which will probably cost about $6 000.

Messrs. D. & J. Jardine have plans on hand for a five-story apartment house of Philadelphia brick, to be built for Mr. Richard Lathers on the southeast corner of Pleasant avenue and 116 street.

Mr. George A. Schellenger has plans on the boards for nine four-story brown stone dwellings, to be built on the south side of Seventy-seventh street, 200 feet west of Ninth avenue, by Messrs Geo. C. Edgar & Son.

Messrs. C. Abbott French & Co. have designed the remodeling of Mr. s J. H. Reed's residence on Sedgwick avenue, Kingsbridge, the cost of which is estimated at $20,000.

Messrs. Lamb & Rich have on the boards plans for two four-story brick, brown stone and terra-cotta residences, 17 and 20x53, to be built at a cost of $75,000, for Messrs. Baker & Son, on the south side of Eighty-second street, 325 feet west of Ninth avenue.

Messrs. E. A. Sargent & Co. have prepared plans for a three-story residence for Mr. Wm. A. Boyd, and one for Mrs. Goin, to be built at Larchmont Manor, N. Y. at a cost of $22 000.

Mr. John J. Kierst will build at Nos. 554 and 556 Water street a five-story brick factory, 49x118 3, for S. Ellis Briggs, of Elizabeth N. J., which will cost about $26,000.

Mr. Julius Kastner has drawn plans for additions to be made to the Schaefer Brewery, on East Fifty-first street, to cost about $8,000.

Mr. R. E. Rogers has designed for Mr. Wm. Spieker, two four-story brick tenments, 25x60, to be built on 146th street, west of Brook avenue, at a cost of $24,000.

Mr. Henry J. Dudley has prepared plans for alterations to be made to the Concert Garden, Eighth avenue, Fifty-ninth to Sixtieth street, which is to be changed into a Riding School, the alterations and a stable adjoining will cost $10,000.

Mr. Wm. Pistor has drawn plans for a $15 000 residence to be built for W. B. Boulton, at Orange Valley, N. J.

Mr. George M. Huss has prepared plans for a School Building to be built at Sing Sing, N. Y., at a cost of $25,000.

Messrs. Schneider & Herter are the architects for three three-story and basement, brick brown stone and terra-cotta residences 16.8x60 each, to be built for Mr. John Fish, on the south side of 129th street, east of Seventh avenue, at a cost of $50,000.

Mr. M. L. Uegrich has designed the alterations to be made to No. 64 West Forty-fifth street, for Mr. Westhimer to cost $6,500.

Messrs. Herter Bros. have designed for Mrs. Kurzman, a five-story brick stone and terra-cotta house, 25x69 to be built at a cost of $17,500 on the northwest corner of Bayard and Elizabeth streets.

Messrs. Oxley, Giddings & Enos of Canal street will build a five-story brick factory, at a cost of $60,000, on the southwest corner of Navy and Concord streets, Brooklyn.

Messrs. Post & McCord, 102 Broadway, have been awarded the contract for the iron roof of the City Hall, Fall River, Mass.

Mr. Jos. M. Dunn reports plans on hand for alterations to be commenced at once, of building No. 38 Broad street, and 31 and 33 New street, for Francis P. Furnald, President of the Brooklyn Fire Insurance, the improvement will cost about $40 000.

The Trustees of the Home for Old Men and Aged Couples propose to erect a new building on Morningside avenue, between 113th and 114th streets, to cost $60,000.

Mr. W. H. Beers, of the Tribune Building, reports plans on the boards for four residences to be erected on Harrison street, Orange, N. J. for Mr. E. D. Lindsey at a cost of about $40,000.

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